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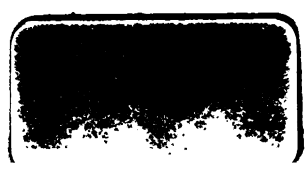

SUPPLEMENT

TO

BERGEN'S EPITOME

OF

NAVIGATION,

CONTAINING THE

NEW QUESTIONS

REQUIRED BY

THE BOARD OF TRADE,

ON AND AFTER THE 1st OF AUGUST, 1881.

BY

WILLIAM CULLEY BERGEN,

MASTER IN THE MERCANTILE MARINE,

AUTHOR OF BERGEN'S "MARINE ENGINEER," BERGEN'S "SEAMANSHIP," ETC.

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1881.

PREFACE.

The following work is adapted to the requirements of the Board of Trade after the 1st of August, 1881; a few Tables required for the solution of the questions are given, so that those persons who have the former editions of Bergen's Navigation will not need any other work

It is intended to enlarge this supplement as soon as covenient.

The author is indebted to Capt. Wm. B. Duncan, Teacher of Navigation, South Shields, for his valuable help and useful suggestions, while the work was passiug through the press.

WM. C. BERGEN.

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HINTS TO CANDIDATES.

1. Before presenting themselves at the Examination Rooms, candidates should see that their applications are properly filled up, and that their papers and testimonials are in regular order; any mistake or omission in regard to these will cause delay and disappointment.

(*a*) *Second Mates* should show on their applications the whole of their service since they first went to sea.

(*b*) *Only Mates, First Mates and Masters* should show on their applications the whole of their service since the date of their last certificate.

(*c*) *All Grades* must show 12 months service in a square rigged vessel, as seaman, mate, or master; otherwise they can only obtain certificates for steamers.

(*d*) *All Grades* must produce good testimonials for their last 12 months service, from the date of the examination.

(*e*) The time upon the application must be in *consecutive order.* All service, whether as Apprentice, Boy, O.S., A.B., Cook, Steward or Carpenter, must be shewn; and if a candidate has been on shore for more than two months at a time, he must state on his application what he has been doing during the interval.

2. Second Mates' service *in the coasting trade does not count* to entitle them to pass as First Mate or Master; but such service must appear upon the applications.

3. Pens and ink are provided in the Board Room, and Candidates must not on any account take books or papers of any kind into the Board Room, except their applications, testimonials, and discharges. This rule does not apply to penholders or pens.

No communication between Candidates is allowed, and a Candidate infringing this rule, or assisting any other will be instantly dismissed, and will lose the fee he has paid.

4. Candidates are recommended to be calm and steady, and not to begin to work until they have attended to the following rules.

(*a*) As soon as you receive your examination paper from the examiner copy your rotation number into the examination paper, and write the name of the port, day of the month, and the year, in their appropriate places; also write your name close to the foot of the page on both sides of every sheet you receive; be specially careful to do this.

5. Keep your work well up towards the top of the page, close and compact, and do not spread it all over the sheet; otherwise if you make any errors you will not have room to commence the work afresh; write the names of the latitude in, longitude in, declination, &c., and the answers to the questions clearly and neatly.

If your paper is returned to you for correction, do not leave any of the incorrect work standing on the paper, but draw your pen across it and cancel it.

Keep the minor corrections abreast of the work they belong to.

6. You are not allowed to leave the premises during the examination, but you may go to the retiring room if you give up the paper on which you are engaged, and ask leave to do so.

WM. C. BERGEN.

Consecutive Office No. 178.
Departmental 895.
Examinations 11.

BOARD OF TRADE,
Marine Department,
January, 1881.

EXAMINATION

FOR

CERTIFICATES OF COMPETENCY

OF

MASTERS AND MATES OF FOREIGN-GOING STEAMSHIPS.

Preliminary.

On and after the 1st day of March, 1881, certificates of competency will be issued subject to the examinations herein-after described, for officers who have served in steamships, and who, owing to absence of service in square rigged sailing ships, cannot under the existing regulations obtain certificates of competency to act in the capacity of masters or mates of square rigged steamships.

These certificates will entitle the holders to go to sea as masters and mates of foreign-going steamships, but will not entitle the holders to go to sea as masters or mates of foreign-going sailing ships.

The forms of certificates will differ from those at present in use.

There will be no distinction in respect of "fore and aft," and "square-rigged" steamships.

Regulations as to Examinations.

QUALIFICATIONS FOR CERTIFICATES OF COMPETENCY FOR FOREIGN-GOING STEAMSHIPS ONLY.

Examination in Colours.—All candidates for certificates of competency must pass the Examination in colours.

A Second Mate.—Must be 17 years of age, and must have been four years at sea.

In Navigation.—He must write a legible hand, and will be required to give in writing definitions of various astronomical and other terms used in navigation. He must have a competent knowledge of the first five rules of arithmetic and the use of logarithms. He must be able to work a day's work complete, correcting the

courses for deviation, leeway, and variation. He will be required to find the latitude by meridian altitude of the sun, and the difference of longitude from a given departure by parallel sailing ; also to find the course and distance from one position to another by Mercator's method. He will be required to find the time of high water at a given port, to observe and calculate the amplitude of the sun, and to find the error of the ship's compass therefrom, and also the deviation, the variation being given. He must be able to find the daily rate of the chronometer from error observed, and to find the longitude from altitude of the sun by the usual methods. He must understand the use of the sextant with its adjustments, and be able to observe with it, find the index error by the horizon, and read off and on the arc. He must also pass a satisfactory examination in the International Code of Signals.

In Seamanship.—He must give satisfactory answers as to the standing and running rigging of steamships ; as to bending, unbending, setting, reefing, taking in and furling sail ; as to sending masts and yards up and down, &c., &c. ; as to seeing everything in readiness and clear for getting under way, and as to the precautions to be then observed with regard to engines, propeller, &c., ; as to the management of a steamship when under canvas ; and as to dunnaging and stowing cargo, &c. He must have a thorough knowledge of the rule of the road as regards both steamers and sailing vessels, their regulation lights, and fog, and sound signals, and be able to describe the signals of distress and the signals to be made by ships wanting a pilot, and the liabilities and penalties incurred by the misuse of these signals. He must be able to mark and use the lead and log lines. He must also understand the construction, use, and action of the sluices, and of the water-ballast tanks, engine room telegraph, &c. ; the use and management of the rocket apparatus in the event of his vessel being stranded, and other questions of a like nature, appertaining to the duties of the second mate of a steamship, which the examiner may think necessary to put to him.

An Only or First Mate.—An only mate must be 19 years of age, and must have served five years at sea. A first mate must be 19 years of age and must have served five years at sea, of which one year must have been as second or only mate of a foreign going steamship.

In Navigation.—In addition to the qualifications required for a second mate, an only, or first mate must be able to find the true bearing of the sun and the error of the ship's compass from an observed azimuth of the sun, both from an altitude and also from the " Time Azimuth Tables," and with the variations given compute the deviation ; to find the latitude from a single altitude of the sun off the meridian, and to be able to use and adjust the sextant, and to find the index error by the sun, and also to ascertain the true bearing of the sun and the ship's position by Sumner's method by projection. He must also be conversant with the use of Mercator's chart and be able to find, on either a *true* or *Magnetic* chart, the course to steer and the distance from one given position to another ; and find the ship's position on the chart from cross bearings of two objects ; from two bearings of the same object, the course and distance between the bearings being given ; and also the distance of ship from the object at the time of taking the second bearings.

In Seamanship.—In addition to the qualifications required for a second mate, a more extensive knowledge of seamanship will be required, as to shifting large spars, rigging sheers, taking lower masts in and out, how to moor and unmoor ship and to keep a clear anchor, to carry out an anchor ; how to manage a steamship in stormy weather, and how to rig purchases for getting heavy weights, anchors, machinery, &c., in and out. He must give satisfactory answers as to the ventila-

tion of holds, and the stowage of explosives. He must be able to describe the effects of the screw race upon the rudder; and the effect produced on the direction of the head of the ship by going (ahead) (astern) with a (right) (left) handed screw when the rudder is (ported) (starboarded). He must also know how to rig a sea anchor, and what means to apply to keep a steamer with machinery disabled out of the trough of the sea, and lessen her lee drift. How to turn a steamship short round; how to get cast of deep sea lead in heavy weather, and other questions of a like nature appertaining to the duties of the first mate of a steamship, which the examiner may think necessary to put to him.

A Master.—Must be 21 years of age, and have been six years at sea, of which one year must have been as first mate in a foreign going steamship, and one year as second or only mate; or he must have been six and a half years at sea, of which two and a half years must have been as second or only mate, during the last 12 months of which he must have been in possession of a first mate's certificate.

In Navigation.—In addition to the qualifications required for a second and first mate, he must be able to compute the latitude from the meridian altitude of a star, &c.; he must be able to find the magnetic bearing from equidistant compass bearings of any fixed object when at sea, and compute the deviation therefrom, He must construct a deviation curve upon a "Napier's" diagram which will be furnished by the examiner, and understand the practical application of the same, and give written answers to certain practical questions on the effect of the ship's iron upon the compasses, the method of determining the deviation, and compensating same by magnets and soft iron. He will be required to find the course to steer by compass in order to counteract the effect of a given current, and find the distance the ship will make good towards a given point in a certain time, and to work out practically the correction to apply to soundings taken at a given time and place, to compare with the depth marked on the chart.

In Seamanship.—In addition to the qualifications required of a second and first mate, he must be able to construct rafts and jury rudders suitable for a screw steamship. He will be examined as to his resources for the preservation of the ship's crew in the event of wreck; as to the management of steamships in heavy weather; as to rescuing the crew of a disabled ship; as to steps to be taken when a ship is on her beam ends; or if disabled and on a lee shore. How to use steam appliances in the event of fire, and the best arrangement for towing vessels under different circumstances, placing ship in dry dock, directing repairs, and the mode of procedure if putting into port in distress with damage to cargo and ship. He must possess a sufficient knowledge of what he is required to do by law, as to entry and discharge, and the management of his crew, and as to penalties, and entries to be made in the official log, and a knowledge of the measures for preventing and checking the outbreak of scurvy on board ship, and the law as to load line marks, the entries and reports to be made respecting them. He will be questioned as to his knowledge of invoices, charter party, bills of lading, Lloyd's agent, and as to the nature of bottomry, also bills of exchange, surveys, averages, &c, and such other operations and duties of a like nature, appertaining to the management of a steamship, as the examiner may consider it necessary to touch upon.

T. H. FARRER,
Secretary.

THOMAS GRAY,
Assistant Secretary.

Consecutive Office Number (No. 179).
Departmental No. 986.
Examination No. 12.

BOARD OF TRADE,
Marine Department,
January, 1881.

NOTICE OF ALTERATIONS IN THE EXAMINATIONS OF MASTERS AND MATES.

From the 1st of August, 1881, Candidates for Second, Only, First Mates', and Masters' Certificates of Competency, will, in addition to the present requirements for these grades, be required to pass an examination in the subjects specified below.

IN NAVIGATION.

A Second Mate will be required to find the time of high water at a given port; to observe and calculate the amplitude of the sun, and to find the error of the ship's compass therefrom, and also the deviation, the variation being given. He must also be able to find the daily rate of the chronometer from error observed, and to find the longitude by altitude of the sun by the usual methods.

An Only Mate will be required to find the true bearing of the sun, and the error of the ship's compass from an observed azimuth of the sun both from an altitude and also from the "Time Azimuth Tables," and with the variation given compute the deviation; to find the latitude from a single altitude of the sun off the meridian, and also to ascertain the true bearing of the sun and the ship's position by Sumner's method by projection. He must also be conversant with the use of Mercator's chart, and be able to find, on either a *true* or *magnetic* chart, the course to steer, and the distance from one given position to another; to find the ship's position on the chart from cross bearings of two objects; from two bearings of the same object, the course and distance between the bearings being given; and also to find the distance of the ship from the object at the time of taking the second bearings.

A First Mate will also be required to find the true bearing of the sun from the "Time Azimuth Tables," and with the variation given compute the deviation, and also work out the same problems, on either a *true* or *magnetic* chart, as are required of a candidate for an Only Mate's certificate. (See above.)

A Master will also be required to find the true bearing of the sun from the "Time Azimuth Tables," and with the variation given compute the deviation, and work out the same problems, on either a *true* or *magnetic* chart, as are required from the Only or First Mate. He will also be required to find the course to steer by compass in order to counteract the effect of a given current, and to find the distance the ship will make good towards a given point in a certain time, and to *work out practically* the correction to apply to soundings taken at a given time and place, to compare with the depth marked on the chart.

IN SEAMANSHIP.

Besides the subjects already prescribed in the rules for the ordinary Examinations, Candidates for Second, Only, First Mates', and Masters' Certificates of Competency, will be required to give satisfactory answers as to their knowledge of the additional subjects (applying more paticularly to Steamships) which are specified in the Rules of Examination for Certificates of Competency for Foreign-going Steamships.

T. H. FARRER,
Secretary.

THOMAS GRAY,
Assistant Secretary.

NOTICE TO CANDIDATES.

1. Candidates are required to appear at the examination room punctually at the time appointed.

2. Candidates are prohibited from bringing into the examination room books or paper of any kind whatever. The slightest infringement of this regulation will subject the offender to all the penalties of a failure.

3. In the event of any candidate being detected in defacing, blotting, writing in, or otherwise injuring any book or books belonging to the Board, the papers of such candidate will be detained until the book or books so defaced be replaced by him. He will not, however, be at liberty to remove the damaged book, which will still remain the property of the Board.

4. In the event of any candidate being discovered copying from another, or affording any assistance or giving any information to another, or communicating in any way with another, during the time of examination, he will subject himself to a failure and its consequences.

5. No candidate will be allowed to work out his problems on a slate or on waste paper.

6. No candidate will be permitted to leave the room until he has given up the paper on which he is engaged.

7. Candidates will be allowed to work out the various problems by the method and tables they have been accustomed to use. At the expiration of the time allowed for the completion of the problems, as laid down in the Rules issued by the Board of Trade from time to time, they will, if they have not finished, be declared to have failed, unless the Local Marine Board or Examiner see fit to lengthen the period in any special case. If, however, the period is lengthened in any case, the special circumstances of that case and the reasons for lengthening the period will be reported to the Board of Trade by the Examiners at the time they send in the report on Form Exn. 14.

8. Candidates will find it more convenient, both here and at sea, to correct the declination and other elements from the Nautical Almanac by the "hourly differences" which have been given in that work in order to facilitate such calculations ; they will thereby render themselves independent of any proportional or logarithmic table for such purpose. The candidates are referred to the " Explanation" given at the end of the Nautical Almanacs for further information on this subject.

9. The corrections by inspection from tables given in many works on navigation will not be allowed (see Tables IX., XI., and XXI. in Norie's Epitome, &c.); every correction must appear on the papers of the candidates.

10. Candidates are expected to bring their answers to all problems within, or not to exceed, a margin of one mile of POSITION from a correct result, with the exception of the ship's position by " Sumner's" method, where a margin of 2½ miles may be allowed.

11. In finding the longitude by chronometer the logarithms used in finding the hour angle should be taken out for seconds of arc, also accuracy should be observed in computing the hour angles for the projection, by " Sumner's" method.

12. In all other problems the logarithms to the nearest minute will be sufficiently correct for all grades, except extra master, from whom a degree of precision will be required both in the work and in the results, beyond what is demanded from the inferior grades.

THOMAS GRAY,
Assistant Secretary.

Board of Trade,
Marine Department, 27th September, 1880.

EXAMINATIONS

OF

MASTERS AND MATES.

Notice to Examiners and Candidates.

The following Rules as to the time to be occupied by Candidates in their Examinations are to be substituted for those at present in force.

Examinations for Certificates of Competency for Foreign-going Steamships.

Candidates for Second Mate's Certificates of Competency must complete the whole of their Examination in Navigation in *eight hours*, including the time allowed for writing the definitions (Exn. 4[a]), the paper on the adjustment of the sextant, and the correction of *all* errors and oversights; but the nautical problems on Forms "Exn. 4" and "Exn. 5" must be completed within *six hours*, and without the Candidates leaving the premises during that period.

Candidates for Only and First Mate's Certificates must complete the whole of their Examination in Navigation in *eleven and a half hours*, including the time allowed for the papers on the adjustment of the sextant, and the chart, and for the correction of *all* errors and oversights; but the nautical problems on Forms "Exn. 4," "Exn. 5," and "Exn. 6" must be completed within *six hours*, and without the Candidates leaving the premises during that period.

Candidates for Master's Certificates must complete the whole of their Examination in Navigation in *fourteen hours*, including the time allowed for the papers on the sextant, the chart, and the compass deviation, and for the correction of *all* errors and oversights; but the problems on Forms "Exn. 4," "Exn. 5," and "Exn. 6" must be completed within *six hours*, and without the Candidates leaving the premises during that period.

Candidates after finishing the problems required of the respective grades on the first day of Examination, should proceed, until the end of that day, with such subjects as the definitions, sextant, chart, and Question 19 of Form "Exn. 7."

The Sumner Problem (*Exn.* 6ª) must on no account be given out to any of the grades on the first day of the Examination, but should be the commencement of the Candidate's work on the second day, and on completion of this problem the Candidates for Masters' Certificates should proceed with the problems on Paper "Exn. 7."

Examinations for Certificates for Home Trade Passenger Ships.

On and after the 1*st August next* some alterations will be made in the Examinations for Home Trade Mates' and Masters' Certificates, and the time to be allowed Candidates for completing the whole of their arithmetical and chart papers must not exceed, in the case of the Mate *five hours*, and in that of the Master *six hours*.

Examinations for the Ordinary Foreign-going Certificates.

On and after the 1*st August next* Candidates for the Ordinary Foreign-going Certificates of Competency will be allowed the same amount of time to perform their navigation, &c., as hereinbefore laid down for the respective grades for Foreign-going Steamship Certificates.

Examinations for Certificates of Competency as Masters of Pleasure Yachts.

Candidates for Certificates as Masters of Pleasure Yachts will be allowed the same amount of time for completing their Examinations as the Ordinary Masters.

Punctually at the expiration of the prescribed time all the papers should be called up, whether completed or not, and if not completed the Candidate will be declared to have failed, unless the Local Marine Board or the Examiners see fit to lengthen the period in any special case ; if however the period is lengthened in any case, the special circumstances of that case, and the reasons for lengthening the period, together with the time allowed, must be reported to the Board of Trade by the Examiners in the column for "remarks" on the Form "Exn. 14."

It is anticipated that but few of the Candidates for Certificates of Competency for any of the foregoing grades will require the whole of the time herein allowed for completing their Examination in Navigation ; and ample time has been prescribed, so that Candidates may perform their work in a careful, clear, and legible manner, and to the entire satisfaction of the Examiners.

THOMAS GRAY,
Assistant Secretary.

Marine Department,
Board of Trade,
March 1881.

SUPPLEMENT TO NAVIGATION.

PRELIMINARY NOTE

On the Degree of Dependence to be placed on the Results of Nautical Computations.

Raper, in page vii. of the preface to the 1st edition of his "Navigation," says, "Very indistinct and erroneous notions prevail among practical persons on the subject of accuracy of computation." We shall therefore give a few instances of the great errors that may arise from slight errors in the question, or from taking unsuitable data.

For example: Multiply 44110 by 225 by common logarithms. Now the log of 225 to 9 places of decimals is 2·352182518. Most writers on Navigation give this to 6 places, as 2·352183, which gives the answer to the preceding question as 9924750; but one writer gives the log of 225 as 2·352182, which gives the answer to the question as 9924727·27 nearly.

Thus the slight difference of 1 in the 6th decimal place of the log causes a difference of 22·93 nearly in the answer.

Exn. 4. *Port of*_____ Rotation No.

EXAMINATION PAPER, No. I.

TO BE USED BY A CANDIDATE FOR A CERTIFICATE OF COMPETENCY AS A

SECOND MATE.

*This Paper to be used at the above Port this*_____*day of*_____18

Space for Minor Corrections.

1.—Multiply 47 by 25 by common logarithms.

47	log.....	1·672098
25	log.....	1·397940
1175	log.....	3·070038

Table XXIV. Add the logs of the multiplicand and multiplier together, the sum is the log of the product.

See Bergen's Navigation, pages 17 and 19, Articles 15 and 20.

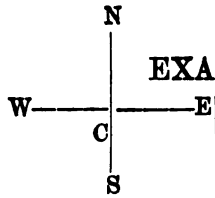
2.—Divide 2868 by 45 by common logarithms.

2868	log.....	3·457579
45	log.....	1·653213
63·73	log.....	1·804366

Table XXIV. Subtract the log of the divisor from the log of the dividend; the remainder is the log of the quotient.

See Bergen's Navigation, page 18, article 18.

The Candidate should sign his name in full at the foot of every page.



Space for Minor Corrections.

	N 50° E
V 25°W } D 16 W }	41 W
	N 9 E

	S 23° E
L.	3
	S 20 E
V 25°W } D 16 W }	41 W
	S 61 E

	S 39°E
L.	3
V 25°W } D 22 W }	S 36 E 47 W
	S 83 E

	N 0°W
V 25°W } D 12 E }	13 W
	N 13 W

	N 23°W
L.	3
	N 26 W
V 25°W } D 14 E }	11 W
	N 37 W

	S 68°E
L.	3
	S 65°E
V 25°W } D 17 W }	42 W
	S 107 E
	180
	N 73 E

	S 84°E
	51 W
V 25°W } D 26 W }	S 135 E
	180
	N 45 E

	S 6 E
V.	25 W
	S 31 E

PAPER I.
EXAMINATION FOR SECOND MATE.

Hors.	Courses.	Knts.	10ths	Winds.	Lee-way.	Dev.	Remarks.
1	S 23° E	6	3	E	3°	16°W	
2		6	5				A Point, Bard Head
3		6	2				in Lat. 60° 6′N
4		6	0				Long. 1 4W
5	S 39° E	6	2	E.N.E.	3°	22°W	bearing by Compass
6		6	3				S50°W
7		6	4				
8		7	1				
9	N	7	0	E.N.E.	0°	12°E	(Ship's Head S28°E
10		7	1				Deviation as per log)
11		6	9				Dist. 12 miles.
12		6	0				
1	N 23° W	6	1	N.E.	3°	14°E	Variation 25°W
2		6	2				
3		6	3				
4		6	4				
5	S 68° E	6	4	N.E.	3°	17°W	A current set
6		6	3				Correct Magnetic
7		6	2				S 6°E
8		6	1				
9	S 84° E	7	2	N.N.E.	0°	26°W	17 miles from the
10		7	2				time the departure
11		7	4				was taken to the end
12		8	2				of the day.

Correct the Courses for Deviation, Variation, and Leeway, and find the Course and Distance from the given Point, and the Latitude and Longitude in, by Inspection.

Corrected Courses.	Dist.	N.	S.	E.	W.
N 9°E	12	11·9		1·9	
S 61 E	25		12·1	21·9	
S 83 E	26		3·2	25·8	
N 13 W	27	26·3			6·1
N 37 W	25	20·0			15·0
N 73 E	25	7·3		23·9	
N 45 E	30	21·2		21·2	
S 31 E	17		14·6	8·8	
		86·7	29·9	103·5	21·1
		29·9		21·1	
		56·8		82·4	

Lat. left 60° 6′ N — Long. left 1° 4′ W
Diff. lat. 57 N — Diff. long. 2 48 E

Lat. in 61 3 N — Long. in 1 44 E

2)121 9

Mid lat. 60 34

TO FIND THE DIFF. LONGITUDE.

Mid lat. 60° in Table II. and diff· 82·5 in lat col. give in dist. col. 165
„ 61 „ 82·4 „ 170

2)335

6,0)16,7·5

diff long 2° 47′·5

TO FIND COURSE AND DISTANCE.

The nearest dep. and diff. lat. to 82·4 and 56·8, in Table II. are dep. 82·9 and diff. lat. 55·9 which correspond to the course 56° at the bottom of the Table, and distance 100 in the dist. column.

Hence we have Course N 56°E Distance 100 miles

Remarks. In the first, or departure course, Bard Head bears S 50°W from the ship, hence the ship bears N 50°E from Bard Head.

The Variation and Deviation are both W; hence their sum is W.

Draw two lines at right angles to represent the N, S, E and W points of the Compass. Conceive yourself at the centre of the Compass, look in the direction N 50° E, allow the sum of the W variation and W deviation to the left hand; thus the true course is found to be N 9° E.

The second course is S 23°E, look in that direction and allow the leeway from the wind, and proceed as in the example.

The fourth course is N, and the difference between W var. and E dev. is of the same name as the greater, namely W, and must be allowed to the left.

The sixth and seventh courses are each greater than 90°, take each of them from 180° and change their names.

The eighth course has only to be corrected for variation.

From a *Traverse Table* as is done in the example. The first corrected course, in the Table, is N 9° E, enter Table II. with 9° at the top of the Table, since 9° is less than 45°, and with the distance 12 in the column marked Dist., in the same line with 12 there are the numbers 11·9 and 1·9, in the columns marked Lat. and Dep. respectively, at the top of the Table.

As the course is N and E, put the Lat. 11·9 in the Traverse Table in the column marked N, and the Dep. 1·9 in the column marked E.

The next course is S 61° E, as 61° is greater than 45° it is found at the bottom of Table II., and opposite the distance 25, the Lat. and Dep. taken from the bottom of the Table are 12·1 and 21·9 respectively, put these numbers in the S and E columns respectively. Proceed with the other courses and distances in the same manner.

Add the numbers in the N, S, E and W columns together respectively; take the difference between the N and S column, and between the E and W column, respectively; these differences will be the diff. lat. and dep. made good respectively.

As the diff. lat. and lat. left are both of the same name, add them together their sum is the lat. in; add the lat. in to the lat. left, half their sum is the mid. lat. Proceed to find the diff. long. as in the question.

As the minutes of the mid. lat. are near half a degree, take half the sum of the distance found by mid. lats. 60 and 61 for the diff. long.

PAPER I.

EXAMINATION FOR SECOND MATES.

4.—1877, March 20th, in longitude 96° 12′ E, the observed meridian altitude of the Sun's Lower Limb was 50° 52′ 10″ bearing North, index error + 1′ 20″, height of eye 18 feet.

Required the Latitude.

	d.	h.	m.	s.
A.T.S. Mar.	20	0	0	0
Long. E.	—	6	24	48
A.T.G. Mar.	19	17	35	12

6·4

° ′
Long. 96 12 E
4

6,0)38,4 48

6 24 48

Space for Minor Corrections.

Var.
59·24
6·4

23696
35544

6,0)37,9·136

6 19·1

Dec.
0° 0′ 20″N.
6 19 S.

0 5 59 S.

	°	′	″	
Obs. alt.	50	52	10	N.
T.E.	+	1	20	
	50	53	30	
Dip.	—	4	11	Table V.
	50	49	19	
Corr.	—	0	42	Table VII.
	50	48	37	
Sem.	+	16	5	N.A.
True alt	51	4	42	
Z.D.	90	0	0	
Dec.	38	55	18	S.
	0	5	59	S.
Latitude	39	1	17	South

5.—In latitude 86° 49′ the departure made good was 471 miles.

Required the difference of Longitude by parallel sailing.

Lat. 86° 49′	Sec. 0·096608	Table XXV.
Dep. 471	Log 2·673021	Table XXIV.
Diff. long. 588·8	Log 2·769629	

REMARKS ON PARALLEL SAILING.

Add the Log Sec. of the lat., rejecting 10 in its index, and the log of the dep. together, the sum is the log of the diff. long.

Explain Meridian Altitude.

The Candidate should sign his name in full at the foot of each page.

REMARKS ON THE LATITUDE BY MERIDIAN ALTITUDE.

Multiply the long. by 4, the product is 384 48, divide 384 by 60, the quotient is 6 24, annex the 48 to this and the result is 6 24 48, which is the long. in time, in hours, minutes and seconds, and because it is E it must be subtracted from the given day, the remainder is the A.T.G.

Put down the hours of the long. in time, divide the minutes by 6, the result is the long. in time expressed in hours and decimals of an hour, 6·4 and it is the time from the noon of the 20th; that is, the nearest noon.

Take from page I. of the month in the Nautical Almanac, page 38 in the book, the Dec. 0° 0′ 20″ N at noon of the given day, and the Var. 59·24″ for 1 hour at that noon, the 20th.

Multiply the Var. by the long. in time, and divide the product by 60, the result is the correction 6′ 19″ of the Dec. due to the long. in time.

The Dec. on the 20th is N, and the Sun was further S on the 19th, therefore the correction is S.

Take the difference 0° 5′ 59″ between the Dec. and the correction, this difference is the Dec. at the time of observation, and it must be marked S, because the S correction is greater than the N Dec. at the noon of the 20th.

Apply the Index order + 1′ 20″ to the obs. alt., according to its sign, subtract the dip. — 4′ 11″, and corr. — 0′ 42″ and add the sum + 16′ 5″, the result is the true alt., 51° 4′ 42″, which subtract from 90°, the remainder 38° 55′ 18″ is the zen. dist. S when the obs. alt. is N.

As the zen. dist. and Dec. are of the same name, add them together, the sum is the true alt.

PAPER I.

EXAMINATION FOR SECOND MATES—(Continued).

Space for Minor Corrections.

6.—Required the Course and Distance from A to B by calculation on Mercator's Principle.

Lat. of A 49° 42′ N Long. 1° 16′ W
Lat. of B 51 8 N Long. 1 20 E

A Lat.	49° 42′ N	Mer. pts.	3447	Long.	1° 16′ W
B Lat.	51 8 N	Mer. pts.	3582	Long.	1 20 E
	1 26	M.D.L.	135		2 86
	60				60
D. Lat.	86 N			D. Long.	156 E

D. Long.	156	log + 10	12·193125	Table XXIV.
M.D.L.	135	log	2·130334	Subtract Log m.d.l.
Course	49 8	tan.	10·062791	Table XXV.

Course	49° 8′	sec.	0·184222	Table XXV.
D Lat.	86	log.	1·934498	Table XXIV.
Distance	131·4	log.	2·118720	

Course N 49° 8′ E. Distance 131·4 miles.

Remarks—Subtract the log of M.D.L. from the log of D. Long. the remainder is the tan. of the Course.

Add the log the D. Lat. to the sec. of the course, less 10 in its index, the sum is the log of the distance.

REMARKS ON THE TIDES.

At page 107 of the Admiralty Tide Table for 1880, Gibraltar is found in connection with Brest, the Standard Port for Reference, and the Constant for Gibraltar is 2h. 0m.

Again, at page 42, under June and Brest, and on the line marked with 2, the day of the month, the time of the morning tide is given 11h. 32m., but a mark thus — is given for the Afternoon, which denotes that there is no tide at Brest on the Afternoon of the 2nd June, and it is said to be a *Blank Tide.*

Proceed, as in the example, to find the time of the Forenoon, or A.M., tide at Gibraltar. Then proceed to find the Afternoon, or P.M. tide as follows. The tide *after* the one that has been found is wanted. Take out of the Tide Tables the tide *after the one that was used* to find the Forenoon tide.

The time of tide the that was used to find the Forenoon tide is June 2d. 11h. 32m. A.M., and the time of the tide after it is June 3d. 0h. 5m. A.M., and by proceeding as in the question the time of the Afternoon tide at Gibraltar is found to be June 2d. 10h. 5m. P.M.

When there is a *Blank Tide*, the following two *Rules* are sufficient.—

Work from the tide that is given; then, if the A.M. tide required be found, work from the *next tide* in the Tables in order to find the P.M. tide required.

If the P.M. required be found, work from the *previous tide* for the A.M. required.

Exn. 5. *Port of*_____

Rotation No. .

EXAMINATION PAPER, I.

TO BE USED BY A CANDIDATE FOR A CERTIFICATE OF COMPETENCY AS

SECOND MATE.

*This Paper to be used at the above Port this*_____ *day of*_____ 18

N.B.—A Candidate for a Second Mate's Certificate of Competency will be required to work the Questions in Paper Exn. 4, in addition to the Questions in this Paper.

Space for Minor Corrections.

1.—1880, June 2nd. Find the time of High Water at Gibraltar, A.M. and P.M.

	d.	h.	m.		d.	h.	m.	
Stand. Brest June	2	11	32	A.M.	3	0	5	A.M.
Const. Gib.	—	2	0		—	2	0	
H.W. Gib. June	2	9	32	A.M.	2	10	5	P.M.

2.—1877, March 19th, at 6h. 0m. 0s. P.M. App. T. Ship in latitude 36° 18″N, longitude 179° W, the Sun's Magnetic Amplitude was W ¼ N.

Required the True Amplitude, and Error of the Compass; and supposing the Variation to be 12° 30′E, required the Deviation of the Compass for that position of the Ship's Head.

	d.	h.	m.	s.
A.T.S. Mar.	19	6	0	0
Long. W.	+	11	56	0
A.T.G. Mar.	19	17	56	0
	20	0	0	0
		6	4	0

Long 179° 0′ W
4

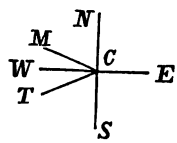
6,0)71,6 0

11 56 0

6·1

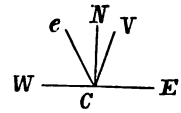
Var.	Dec.					
59″·24	0 0 20 N	Lat.	36 18 N	Sec.	0·093704	Table XXV.
6·1	6 1 S	Dec.	0 6 S	Sin.	7·241877	
5624	0 5 41 S	T. amp.	W 0 7 S	Sin.	7·335581	
35544		M. amp.	W 2 49 N			
6,0)36,1·064		Error	2 56 W			
6 1·0		Var.	12 30 E			
		Deviation	15 26 W			

Fig. for Error



T left of *M* error *W*

Fig. for Dev.



e left of *V* deviation *W*.

See page 114 Bergen's Navigation. Also, Article 84, page 110.

Remarks.—The A.T.G. is 19d. 17h. 56m., as the hours are greater than 12, take the A.T.G. from 20d. 0h. 0m. 0s., the remainder is 6h. 4m., which is the time from the nearest noon, take out the declination for the 20th and correct it as in the question.

The deviation may be found by conceiving the name of the variation to be changed from E to W and it will then be of the same name as the error, add them together and the sum is the deviation W.

The Candidate should sign his name in full at the foot of every page.

EXAMINATION FOR SECOND MATES.—(Continued)

Space for Minor Corrections.

Daily Rate.
Mar. 10 3 15 S
Mar. 18 2 27 S
8 8)48
Gaining daily 6

See page 127 Bergen's Navigation.

Var.
7·06
11·2
1412
7766
6,0)7,9·072
1 19·0

Cosec.
66° 40′ 0″ 0·037055
— 50
66 40 55 0·037005
Diff. 91
55
455
455
50·05

Cos.
68° 36′ 0″ 9·562146
— 183
68 36 34 9·561963
Diff. 537
34
2148
1611
182·58

Sin.
28° 16′ 0″ 9·675390
+ 82
28 16 21 9·675472
Diff. 391
21
391
782
82,11

3.—1877, June 15th, A.M., at Ship in latitude 30° 12′ N, The observed altitude of the Sun's L.L. was 40° 9′ 45″ height of eye 19 feet, time by a Chronometer June 14d. 11h. 17m. 5s. which was 8m. 15s. slow for mean noon at Greenwich on March 10th, and on March 18th was 2m. 27s. slow.

Required the longitude by Chronometer.

	d.	h.	m.	s.
T. chron. June	14	11	17	5
Slow	+		2	27
	14	11	19	32
Gained	—		8	51
M.T.G. June	14	11	10	41

11·2

	d.	h.
Mar.	31	11
Mar.	18	·04
	Mar. 13	88·44
Apl.	30	6
May	31	h.
June	14	11
	88	11

6,0)53,0·64
8 50·6

Dec.

23°	17′	46″	N
+	1	19	
23	19	5	N
90	0	0	
P.D. 66	40	55	

Eq. T.

m.	s.
—0	0·58
+	5·92
+0	5·34

Var.
0·529
11·2
1058
5819
5·9248

Obs. alt.	40°	9′	45″
Dip.	—	4	17
	40	5	28
Corr.	—	1	2
	40	4	26
Sem.	+	15	47
True Alt.	40	20	13

Alt.	40°	20′	13″
Lat.	30	12	0
P.D.	66	40	55
2)137	13	8	
	68	36	34
	28	16	21

sec. 0·063348
cosec. 0·037005
cos. 9·561963
sin. 9·675472

	h.	m.	s.
H.A.	20	17	31
Eq. T. +			5
d			
M.T.S. June 14	20	17	36
M.T.G. June 14	11	10	41
	9	6	55
	60		120
4)546		175	180

log. 9·337788
97
— s
19=3

Longitude 136° 43′ 45″ East.

Remarks on the Correction for the hours of the elapsed time.

$\frac{1}{24}$ = ·0416 = 1 hour expressed as the decimal of a day.

By Multiplying the hours of the elapsed time by ·04, or by ·042 if the elapsed time be great, or the rate high, they will be expressed as the decimal of a day without material error.

Remarks on the change of sign in the Equation of Time.

The M.T.G. is between the 14th and 15th June, on page 1 of the month in the N.A. the sign for the Equation of Time on the 14th is —, but for the 15th it is+. Mark the Eq. T. on the 14th—, and the correction +, take their difference and mark it +, the same as the sign of the greater, as in the question.

The Candidate should sign his name in full at the foot of every page.

Exn. 6.

PAPER I.

otation No.

Port of _____

EXAMINATION PAPER I.

TO BE USED BY A CANDIDATE FOR A CERTIFICATE OF COMPETENCY AS AN

ONLY MATE.

Space for Minor Corrections.

1.—1877, December 26th, mean time at ship 3h. 21m. P.M. in latitude 44° 2′ N, longitude 31° 37′W, the Sun's bearing by Compass WSW altitude L.L. 8° 24′ 50″, height of the eye 19 feet.

Required the True Azimuth, and Error of the Compass; and supposing the variation to be 30° 15′W, required the deviation of the Compass for that position of the Ship's head, both by the Sun's altitude and by the Time Azimuth Tables.

	d.	h.	m.	s.
M.T.S. Decem.	26	3	21	0
Long	+	2	6	28
M.T.G. Dec.	26	5	27	28

5·5

Long 31° 37′ W
4

6,0)12,6 28

2 6 28

Dec.

23°	22′	1″	S
—		31	
23	21	30	S
90	0	0	
P.D. 113	21	30	

Obs. alt.	8°	24′	50″
Dip.	—	4	17
	8	20	33
Corr.	—	6	5
	8	14	28
Sem.	+	16	18
	8	30	46

Var.
5·65
5·5
2825
2825
31·075

By the Altitude

Alt.	8°	30′	46″
Lat.	44	2	0
P.D.	113	21	30
	2)165	54	16
Hf. Sum	82	57	8
Diff.	30	24	22
	22	41	50
			2
T.Az.S	45	23	40 W
T.Az.S	45	24	W
M.Az.S	67	30	W
Err.	22	6	W
Var.	30	15	W
Dev.	8	9	E

sec. 0·004816
sec. 0·143310

Cos. 9·088970
Cos. 9·935766
2)19·172862
Sin. 9·586431
179
503)25200(50
2515
50

By the Azimuth Tables.

	h.	m.		
M.T.S.	3	21 P.M.	·57	1·2
Eq. T.	—	1	7	6
A.T.S.	3	20 P.M.	1 3	7·2

A.T.S. 3h. 20m. P.M., lat. 44°N and Dec. 23°S give True Az. N 134° 28′ W
180

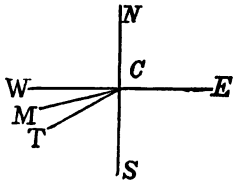
or True Az. S 45 32 W
Mag. Az. S 67 30 W

Err.	21	58	W
Var.	30	15	W
Deviation	8	17	East.

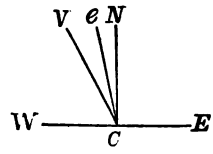
The Candidate should sign his name in full at the foot of every page.

Remarks.—The Board of Trade only require the logs of the arcs in this question to be taken out the nearest minute, therefore take the sec. of 8° 31′ for that of 8° 30′ 46″, and so on. But as the half azimuth is multiplied by 2, and this sometimes causes an error of more than 1 minute of arc, it will therefore be advisable to find the seconds of the half azimuth; as is done in the question.

Figure for error



T to left of M
error W



e right of *v*
deviation *E*

See page 148 Bergen's Navigation.

The deviation may be found by conceiving the name of the variation to be changed from *W* to *E*, it is then of different name to the error, take the difference for the deviation, and name it *E*, the same as the greater.

By the Azimuth Tables.—The M.T.S. is 3h. 21m. P.M., reduce this to A.T.S. as follows; the equation of time on page II. of the month, on the 26th of December is 57s., the var. at page I. is 1·2 which multiplied by the hour of the M.T.G. gives $1{\cdot}2 \times 5 = 6s{\cdot}0$., 6s. added to 57s. is equal to 1m. 3s.; which according to the precept at the top of the page, is the correction to be subtracted from the equation of time to reduce the M.T.S. to A.T.S. Enter Burdwood's Azimuth Tables at page 44, and proceed as in the question.

PAPER I.

EXAMINATION FOR ONLY MATE—Continued.

Space for Minor Corrections.

2.—1877, March 20th A.M., at Ship lat. by account 34° 17′ N, long. 158°E, the observed altitude of the Sun's L.L. South of the observer was 54° 59′ I.E.,—3′ 40″, height of eye 18 feet. Time by watch March 19d. 22h. 18m., which had been found to be slow of apparent time at Ship 1h. 20m. 18s. The difference of Longitude made to the West was 28′ after the error on Apparent time at Ship was determined.

Required the latitude by the Reduction to the Meridian.

	d.	h.	m.	s.
T. watch Mar.	19	22	18	0
Slow.	+	1	20	18
	19	23	38	18
Diff. long.	—		1	52
A.T.S. Mar.	19	23	36	26
Long E.	—	10	32	0
A.T.G. Mar.	19	13	4	26
	20	0	0	0
	10	55	34	
	10·	9		

D.L. 28′W
4
6,0)11,2
1 52

Long 158° 0′E
4
6,0)63,2 0
10 32 0

h. m. s.
24 0 0
A.T.S. 23 36 26
T. fr. noon 23 34

Var.
59·24
10·9
53316
59240
6,0)645·716
10 45·7

° ′ ″
0 0 20 N
0 10 46 S
0 10 26 S

° ′ ″
Obs. alt. 54 59 0 S
I. E. — 3 40
54 55 20
Dip. — 4 11
54 51 9
Corr. — 0 36
54 50 33
Sem. + 16 5
True alt. 55 6 38 S

m. s. Rising.
23 30 | 2·72036
4 | + 260
23 34 | 2·72296

	m.	s.
T. from noon	23	34
Lat. acc.	34°	17′N
Dec.	0	10 S

rising 2·72296
cos. 9·917118
cos. 9·999998
const. 1.

Nat. number 4366 log. 3·640076

True alt.	55	7 S
M.Z.D.	34	27 N
Dec.	0	10 S
Latitude	34	17 North.

Nat. sin. 820318
Nat. cos. 824684

Remarks.—The cosines must be taken out of the Table to 6 places of figures, and the constant number 1 added, as in the question.

See Article 103, pages 156 and 157 Bergen's Navigation.

The Candidate should sign his name in full at the foot of every page

Exn. 7.
(Late E.F. 4.)

Port of _____

Rotation No.

EXAMINATION PAPER I.

TO BE USED BY A CANDIDATE FOR A CERTIFICATE OF COMPETENCY AS A

MASTER ORDINARY.

To be used at the above Port this _____ *day of* _____ 18

N.B.—A Candidate for an Ordinary Master's Certificate of Competency will be required to work the Questions in Papers Exn. 4, *Exn.* 5, *and Exn.* 6, *in addition to the Questions in this Paper.*

Space for Minor Corrections.

1.—1877, August 29th. The observed Meridian Altitude of the Star α Coronae (Alphacca) bearing South was 57° 18′ 20″, height of the eye 21 feet.

Required the Latitude.

Obs. Alt.	57	18	20	S
Dip.	—	4	31	Table V.
	57	18	49	
Ref.	—	0	38	Table IV.
True Alt.	57	18	11	
	90	0	0	
Zen. dist.	32	46	49	N
Naut. Alman. Dec.	27	7	45	N page 852
Latitude	59	54	34	North

Remarks.—It is convenient to look for the right Ascension of the Star in the Table of the "Mean Places of Stars" pages 293 to 295 Nautical Almanac, and then follow the R.A. at the top of the Table for the "Apparent Places of Stars," pages 313 to 369.

The Candidate should sign his name in full at the foot of every page.

EXAMINATION PAPER, NO. I.

FOR SECOND MATE.

1. Multiply 837 by 281, by common logarithms.

2. Divide 5·732 by 2·154, by common logarithms.

3.

Hrs.	Courses.	Knts.	10ths	Winds.	Lee-way.	Devia-tion.	Remarks, &c.
1	S. 42° W.	6	9	W.N.W.	11°	8° W.	A point in Lat. 34° 21′ S., Long. 115° 6′ E.
2		7	1				
3		7	6				
4		7	4				
5	S. 22° W.	6	3	West.	10°	3° W.	bearing by Compass N. 47° E.
6		6	2				
7		6	1				
8		5	4				Dist. 18 miles.
9	S. 24° E.	6	4	S.W.	9°	10° E.	(Ship's head S. 42° W., Deviation as per log.)
10		6	3				
11		6	2				
12		5	1				
1	S. 30° E.	6	9	S.S.W. ½ W.	7°	11°E.	Variation 7° W.
2		6	1				
3		6	6				
4		5	4				
5	N. 84° W.	5	2	S.S.W.	6°	22°W.	A Current set correct magnetic } S.32° W
6		5	3				
7		5	4				
8		5	1				
9	N. 47° W.	4	3	W.S.W.	5°	22°W.	25 miles from the time the departure was taken to the end of the day.
10		4	3				
11		4	2				
12		4	2				

Correct the Courses for Deviation, Variation, and Leeway, and find the Course and Distance from the given Point, and the Latitude and Longitude in by inspection.

4. 1884, January 3rd. In Longitude 25° 50′ W. The observed meridian altitude of the Sun's Lower Limb was 52° 18′ 10″, bearing South, index error + 1′ 10″, height of eye 14 feet.

Required the Latitude ?

5. In Latitude 62° 43′, the Departure made good was 79 miles.

Required the Difference of Longitude by parallel sailing ?

6. Required the course and distance from A to B, by calculation on Mercator's principle ?

Lat. of A.....	50°	55′ N.	Long.....	0°	58′ E.
Lat. of B.....	49	11 N.	Long.....	2	7 W.

The Candidate should sign his name in full at the foot of every page.

7. 1880, July 1st. Find the time of High Water, at Fowey A.M. and P.M.

8. 1884, January 2nd. At 7h. 35m. A.M., Appt. Time at Ship, in latitude 42° 0′ N., Longitude 17° 1′ W. The Sun's Magnetic Amplitude was S.S.E.

Required Amplitude and Error of the Compass; and supposing the Variation to be 23° 50′ W. ?

Required the Deviation of the Compass for that position of the Ship's head ?

9. 1884, January 2nd P.M. at Ship, in Latitude 42° 16′ S. The observed altitude of the Sun's L.L. was 41° 43′, I.E. + 2′ 20″, height of eye 16 feet. Time by a chronometer 2d. 5h. 10m. 16s., which was slow for mean noon at Greenwich 1m. 15s. on December 13th, 1883, and on December 26th was 1m. 2s. slow for mean noon at Greenwich.

Required the Longitude by Chronometer ?

ADDITIONAL FOR ONLY AND FIRST MATE.

10. 1884, February 8th. At 8h. 55m. 17s. A.M., Mean Time at Ship, in latitude 36° 12′ S., longitude 9° 46′E. The Sun's bearing by Compass was E.¼N. the altitude of its L.L. 40° 54′, height of the eye 18 feet.

Required the True Azimuth and Error of the Compass; and supposing the Variation to be 27° 30′ W. Required the Deviation of the Compass for that position of the Ship's head; both from the altitude, and also from the Azimuth Tables. ?

11. 1884, February 8th, A.M. at Ship, in lat. by account 15° 6′ N., long. 18° 22′ W. The observed altitude of the Sun's L.L. South of the observer was 59° 4′ 20″ I.E.—0′ 20″, height of eye 17 feet. Time by watch 7d. 23h. 36m. 14s., which had been found to be 1m. 24s. fast of apparent time at Ship.

The difference of longitude made to the East was 9 miles after the error on Apparent Time at Ship was determined.

Required the Latitude by Reduction to the Meridian ?

ADDITIONAL FOR MASTER.

12. 1884, January 11th. The observed Meridian Altitude of the Star γ Pegasi (Algenib) was 42° 17′ bearing South, height of the eye 14 feet.

Required the Latitude ?

EXAMINATION PAPER, NO. II.

FOR SECOND MATE.

1. Multiply 41·63 by 205·7, by common logarithms.

2. Divide ·7006 by ·0247 by common logarithms.

3.

Hrs.	Courses.	Knts.	10ths	Winds.	Lee-way.	Devia-tion.	Remarks, &c.
1	S.E. ½ E.	5	1	S.S.W.	1½	15°E.	
2		5	2				A point, in Lat. 50° 24′ N., Long 179° 15′ W. bearing by Compass N.E. by N.
3		5	3				
4		5	4				
5	E.S.E.	6	4	South.	1½	18° E.	
6		7	3				
7		7	5				Dist. 17 miles.
8		7	8				
9	E. ½ S.	7	5	S.S.E.	2½	20° E.	(Ship's head S.E. ½ E., Deviation as per log.)
10		6	4				
11		5	5				
12		4	6				
1	E. by N.	4	1	S.E. by S.	2½	20° E.	Variation 14° E.
2		4	2				
3		3	7				
4		2	0				
5	W.S.W.	2	1	S. by E.	¾	16° W.	A current set correct magnetic. } S.S.E. ½ E.
6		2	4				
7		3	3				
8		4	2				
9	W.N.W.	5	4	S.W.	½	24° W.	34 miles from the time the departure was taken to the end of the day.
10		6	6				
11		7	6				
12		8	4				

Correct the Courses for Deviation, Variation, and Leeway, and find the Course and Distance from the given Point, and the Latitude and Longitude in, by Inspection.

4. 1884, February 9th, in Longitude 110° 29′ E. The observed Meridian Altitude of the Sun's Lower Limb was 61° 14′ 30″ bearing North, index error — 1′ 20″, height of the eye 18 feet.

Required the Latitude ?

5. In latitude 13° 18′, the Departure made good was 271 miles.

Required the difference of Longitude by parallel sailing ?

The Candidate should sign his name in full at the foot of every page.

6. Required the course and distance from A to B by calculation on Mercator's principle ?

A Lat.....	55°	7′ N.	Long.....	1°	30′ W.
B Lat.....	57	44 N.	Long.....	10	38 E.

7. 1880, July 2nd. Find the Time of High Water at Bayonne, A.M. and P.M.

8. 1884, February 8th. At 7h. 51m. P.M., Appt. T. Ship, in latitude 61° 15′ S., longitude 80° E. The Sun's Magnetic Amplitude was W. 7° 30′ S.

Required True Amplitude and Error of the Compass; and supposing the Variation to be 45° 18′ W. Required the Deviation of the Compass for that position of the Ship's head ?

9. 1884, February 8th A.M. at Ship, in latitude 36° 12′ S. The observed Altitude of the Sun's L.L. was 40° 54′ 0″, height of eye 18 feet. Time by Chronometer 7d. 20h. 16m. 12s., which was 2m. 24s. fast for mean noon at Greenwich, October 20th, 1883, and on December 15th, 1883, was 1m. 10s. fast for mean noon at Greenwich ?

Required the Longitude by Chronometer ?

ADDITIONAL FOR ONLY AND FIRST MATE.

10. 1884, January 2nd. At 8h. 37m. 48s. P.M., Mean Time at Ship, in latitude 42° 16′ S., longitude 23° 21′ W. The Sun's bearing by Compass was W.N.W., the altitude of its L.L. 41° 43′, I.E. + 2′ 20″, height of the eye 16 feet

Required the True Azimuth and Error of the Compass; and supposing the Variation to be 5° 30′ W. Required the Deviation of the Compass for that position of the Ship's head ? Both from the Altitude and also from the Azimuth Tables.

11. 1884, January 2nd, P.M. at Ship, in lat. by account 7° 23′ N., long. 12° 2′ W. The observed Altitude of the Sun's L.L. South of the observer was 59° 18′ 40″, height of eye 22 feet. Time by watch 1d. 23h. 23m. 42s., which had been found to be 50m. 40s. slow of Apparent Time at Ship.

The difference of Longitude made to the West was 30 miles after the error on Apparent Time at Ship was determined.

Required the Latitude by Reduction to the Meridian.

ADDITIONAL FOR MASTER.

12. 1884, February 20th. The observed Meridian Altitude of the Star α Eridani (Acherner) was 32° 16′ 10″, bearing South, I.E. + 2′ 40″, height of the eye 22 feet.

Required the Latitude ?

EXAMINATION PAPER, NO. III.

FOR SECOND MATE.

1. Multiply 84000 by 82000, by common logarithms.

2. Divide 8742 by 27, by common logarithms.

3.

Hrs.	Courses.	Knts	10ths	Winds.	Lee-way.	D evia-tion.	Remarks, &c.
1	S. 46° E.	4	2	N. 67° E.	2°	18° W	A point, Flambro' Head, in Lat. 54° 7′ N., Long. 0° 5′ W., bearing by Compass S. 56° W.
2		3	4				
3		6	3				
4		6	1				
5	S. 50° E.	6	3	N. 63° E.	3°	18° W	
6		5	2				
7		4	1				Dist. 17 miles.
8		2	4				
9	S. 25° E.	2	1	N. 87° E.	5°	12° W	
10		3	5				(Ship's head S. 46° E., Deviation as per log.)
11		7	3				
12		8	1				
1	N. 67° E.	8	4	S. 48° E.	7°	16° W	
2		7	3				Variation 20° W.
3		6	2				
4		5	1				
5	N. 28° E.	3	4	S. 82° E.	11°	8° W	
6		4	5				Tide estimated to set correct magnetic N. 34° E.
7		5	1				
8		6	0				
9	N. 18° W.	6	3	N. 48° E.	13°	2° E	
10		6	2				
11		5	1				Dist. 9 miles the last 24 hours.
12		4	4				

Correct the Courses for Deviation, Variation, and Leeway, and find the Course and Distance from the given Point, and the Latitude and Longitude, by Inspection.

4. 1884, March 20th. In Longitude 148° 0′ E. The observed Meridian Altitude of the Sun's Lower Limb was 51° 14′ 20″ bearing South, index error — 2′ 10″, height of eye 10 feet.

Required the Latitude?

5. In latitude 54° 17′, the Departure made good was 142 miles.

Required the Difference of Longitude by parallel sailing?

The Candidate should sign his name in full at the foot of every page.

6 Required the course and distance from A to B, by calculation on Mercator's principle?

A Lat.....	50°	35′ N.	Long.....	2°	8′ W.
B Lat.....	49	42 N	Long.....	1	16 W.

7. 1880, July 8th. Find the Time of High Water at Selsea Bill, A.M. and P.M.

8. 1884, March 20th. At 6h. 5m. A.M., Appt. T. Ship, in latitude 32° 16′ N. longitude 25° 42′ E. The Sun's Magnetic Amplitude was N 7¾ E.

Required True Amplitude and Error of the Compass; and supposing the Variation to be 10° 40′ W. Required the Deviation of the Compass for that position of the Ship's head?

9. 1884, March 19th, P.M. at Ship, in latitude 32° 4′ N. The observed altitude of the Sun's L.L. was 25° 15′ 40″, height of eye 19 feet. Time by a chronometer 19d. 15h. 40m. 6s., which was 0m. 3s. slow for mean noon at Greenwich on December 24th, 1883, and on January 5th, 1884, was 0m. 15s. fast for mean noon at Greenwich.

Required the Longitude by Chronometer?

ADDITIONAL FOR ONLY AND FIRST MATE.

10. 1884, December 24th. At 8h. 34m. 29s. A.M., Mean Time at Ship in latitude 38° 14′ S., longitude 80° 50′ E. The Sun's bearing by Compass was E. by S. ½ S., altitude of its L.L. 48° 56′, height of the eye 23 feet.

Required the True Azimuth and Error of the Compass, and supposing the Variation to be 20° 10′ W. Required the Deviation of the Compass for that position of the Ship's head? Both by the Altitude, and also by the Time Azimuth Tables.

11. 1884, December 23rd, A.M. at Ship, lat. by account 53° 49′ S., longitude 48° 52′ W. The observed altitude of the Sun's L.L. North of the observer was 58° 58′, index error + 1′ 20″, height of eye 23 feet. Time by watch 22d. 23h. 37m. 48s., which had been found to be 3m. 42s. fast of apparent time at Ship.

The difference of longitude made to the West was 24 miles after the error on Apparent Time at Ship was determined.

Required the Latitude by the Reduction to the Meridian?

ADDITIONAL FOR MASTER.

12. 1884, March 9th. The observed Meridian Altitude of the Star α Tauri (Aldebaran) bearing North was 52° 10′ 40″, height of the eye 20 feet.

Required the Latitude?

EXAMINATION PAPER, NO. IV.

FOR SECOND MATE.

1. Multiply 4·721 by 9850, by common logarithms.

2. Divide 6781 by 285, by common logarithms.

3.

When the ship changes her longitude from E. to W., or from W. to E., so that the longitude exceeds 180°, as in the following exercise, take the longitude from 360°, change the name of the remainder and it is the longitude in.

Hrs.	Courses.	Knts.	10ths	Winds.	Leeway.	Deviation.	Remarks., &c.
1	S. 79° E.	10	9	S. ¼ E.	3°	19° E.	
2		11	0				A point,
3		11	2				in Lat. - 47° 44′ S.
4		11	4				Long. 179 7 E.
5		11	5				
6	S. 87° E.	12	0	S. ¼ E.	6°	20° E.	bearing by Compass, N 17° W
7		12	1				
8		12	2				
9		12	3				Dist. 21 miles.
10		12	4				
11	S. 67° E.	13	4	S. S. W.	8°	18° E.	(Ship's head S. 79° E.
12		13	5				Deviation as per log.)
1		13	5				Variation 14° E.
2		14	1				
3		14	5				
4	N. 56° E.	13	9	North.	4°	19° E.	A current set, correct magnetic. } N. 34° W.
5		13	6				
6		13	5				
7		13	7				
8		13	3				
9	S. 48° E.	12	5	S. W. by S.	8°	15° E.	23 Miles from the time the
10		12	5				departure was taken to the
11	N. 11° E.	2	4	E. N. E.	65°	2° E.	end of the day.
12		2	6				

Correct the Courses for Deviation, Variation and Leeway, and find the Course and Distance from the given Point, and the Latitude and Longitude in, by Inspection.

4. 1884, April 14th. In Longitude 91° 42′ E. The observed meridian Altitude of the Sun's Lower Limb was 89° 57′ 20″ bearing South, index error — 2′ 40″, height of the eye 17 feet.

Required the Latitude ?

The Candidate should sign his name in full at the foot of every page.

5. In latitude 78° 14′, the Departure made good was 149 miles.

Required the Difference of Longitude by parallel sailing?

6. Required the course and distance from A to B by calculation on Mercator's principle?

Lat. of A.....	50°	26′ N.	Long.....	2°	58′ W.
Lat. of B.....	71	10 N.	Long.....	25	46 E.

7. 1880, July 1st. Find the time of High Water at Falmouth, A.M. and P.M.

8. 1884, April 15th. At 7h. 11m. P.M., Appt. T. Ship, in latitude 59° 12′ N., longitude 178° 20′ E. The Sun's Magnetic Amplitude was N 6¾ W.

Required True Amplitude and Error of the Compass, and supposing the Variation to be 14° 25′ E. Required the Deviation of the Compass for that position of the Ship's head.

9. 1884, April 14th, P.M. at Ship, in latitude 48° 14′ N. The observed altitude of the Sun's L.L. was 35° 35′ 10″, index error — 1m. 30s., height of eye 17 feet. Time by a chronometer 14d. 11h. 32m. 15s., which was 2m. 15s. fast for mean noon at Greenwich on March 6th, and on March 26th was 3m. 51s. fast for mean noon at Greenwich.

Required the Longitude by Chronometer?

ADDITIONAL FOR ONLY AND FIRST MATE.

10. 1884, November 28th. At 3h. 24m. 4s. P.M., Mean Time at Ship, in latitude 42° 17′ N., longitude 31° 29′ W. The Sun's bearing by Compass was S.W. ¼ W., altitude of its L.L. 8° 59′, I. E. + 4′ 10″, height of the eye 19 feet.

Required the True Azimuth and Error of the Compass; and supposing the Variation to be 11° 20′ W. Required the Deviation of the Compass for tha position of the Ship's head. Both by the Sun's Altitude and by the Time Azimuth Tables?

11. 1884, November 29th, A.M. at Ship, lat. by account 54° 35′ S., long. 36° W. The observed altitude of the Sun's L.L. North of the observer was 56° 10′, height of eye 17 feet. Time by watch 29d. 0h. 6m., which had been found to be 42m. 28s. fast of Apparent Time at Ship.

The difference of longitude made to the East was 14 miles, after the error on Apparent Time at Ship was determined.

Required the Latitude by Reduction to the Meridian?

ADDITIONAL FOR MASTER.

12. 1884, April 21st. The observed Meridian Altitude of the Star α Aurigæ (Capella) bearing North was 29° 16′ 45″, index error — 2′ 15″, height of the eye 18 feet.

Required the Latitude?

The Candidate should sign his name in full at the foot of every page.

EXAMINATION PAPER, NO. V.

FOR SECOND MATE.

1. Multiply 345·1 by 27·54, by common logarithms.

2. Divide ·0847 by ·672, by common logarithms.

Note. Solve this question by both common and negative indices.

3.

Hrs.	Courses.	Knts.	10ths	Winds.	Lee-way.	Devia-tion.	Remarks, &c.
1	N. 23° E.	6	5	E.	3°	18°E.	
2		6	6				A point in Lat. 57° 42′ N. Long. 2 2 W.
3		6	9				
4		6	3				
5		6	9				
6		7	2				
7		7	9				bearing by Compass, N. 68° W.
8	N. 6° E.	7	6	E.N.E.	6°	12°E.	
9		7	3				
10		7	3				Dist. 20 miles.
11		7	6				
12	N. 3° W.	7	4	E.N.E.	8°	10°E.	(Ship's head N. 23° E. Deviation as per log.)
1		7	5				
2	E.	7	7	N.N.E.	14°	16°E.	
3		7	5				Variation 26° W.
4		7	3				
5		7	2				
6		7	4				
7		7	1				A Current set, correct magnetic. } N. 45° E
8	S. 68° E.	7	4	N.E.	17°	7°E.	
9		7	8				
10	S. 45° E.	7	7	E.N.E.	25°	3°W	16 miles from the time the departure was taken to the end of the day.
11		7	2				
12		7	2				

Correct the Courses for Deviation, Variation, and Leeway, and find the Course and Distance from the given Point, and find the Latitude and Longitude in, by Inspection.

4. 1884, May 21st. In Longitude 175° 44′ E. The observed meridian altitude of the Sun's Lower Limb was 54° 18′ 20″, bearing South, index error 0, height of eye 22 feet.

Required the Latitude ?

In Latitude 84° 49′ the Departure made good was 89 miles.

Required the Difference of Longitude by parallel Sailing ?

The Candidate should sign his name in full at the foot of every page.

6. Required the Course and Distance from A to B by Calculation on Mercator's principle.

A Lat.....	42°	15′	N.	Long.....	8°	40′ W.
B Lat.....	38	54	N.	Long.....	71	39 W.

7. 1880, July 2nd. Find the time of High Water at Arcachon, A.M. and P.M.

8. 1884, May 20th. At 7h. 24m. A.M., Appt. T. Ship, in latitude 46° 14′ S., longitude 125° 16′ W. The Sun's observed Amplitude was N E, by E.

Required the True Amplitude and Error of the Compass ; and supposing the Variation to be 12° 45′ E. Required the Deviation of the Compass for that position of the Ship's head ?

9. 1884, May 20th P.M. at Ship, in latitude 21° 4′ S. The observed Altitude of the Sun's L.L. was 24° 12′, height of eye 17 feet. Time by a chronometer 20d. 5h. 10m. 16s., which was 2m. 14s. fast of Greenwich mean noon on January 25th, and on April 16th, was 1m. 22s. slow for mean noon at Greenwich?

Required the Longitude by Chronometer ?

ADDITIONAL FOR ONLY AND FIRST MATE.

10. 1884, October 27th. At 8h. 5m. 6s. A.M., Mean Time at Ship, in latitude 33° 17′ S, Longitude 55° 36′ E. The Sun's bearing was E. by S. ½ S. the altitude of its L.L. 36° 13′, Height of the Eye 16 feet.

Required the True Azimuth and Error of the Compass ; and supposing the Variation to be 24° 20′ W. Required the Deviation of the Compass for that position of the Ship's head.

11. 1884, October 25th, A.M. at Ship, lat by account 29° 35′ N. Long 24° 16′ W. The observed altitude of the Sun's L.L. near the meridian was 47° 50′ bearing S. I.E. + 1′ 40″, Height of the eye 19 feet, Time by watch 25d. 1h. 58m, which had been found to be 2h. fast on apparent time at Ship. The difference of longitude made to the West was 6 miles, after the Error on Apparent Time at Ship was determined.

Required the Latitude by Reduction to the Meridian ?

ADDITIONAL FOR MASTER.

12. 1884, May 18th. The observed Meridian Altitude of the Star β Orionis (Rigel) bearing South was 64° 27′ 10″. Height of the eye 19 feet, Required the Latitude ?

EXAMINATION PAPER, NO. VI.

FOR SECOND MATE.

1. Multiply ·006484 by ·000721, by common logarithms.

2. Divide 94·72 by ·1214, by common logarithms.

Note. Solve the two preceding questions by both common and negative indices?

3.

Hrs.	Courses.	Knts.	10ths	Winds.	Leeway.	Deviation.	Remarks, &c.
1	N. 84° W.	4	0	S. S. W.	3°	19° W	
2		4	7				A point,
3		4	5				in Lat. - 14° 26′ S.
4		4	8				Long. 129 37 W.
5	S. 68° W.	4	6	N. W.	6°	14° W	
6		4	9				bearing by Compass, S.,
7		5	5				
8	S. 45° E.	5	7	S. S. W.	14°	7° E	Dist. 22 miles.
9		5	9				
10		6	3				
11	N. 39° W.	7	7	W. S. W.	17°	17° W	(Ship's head, N. 84° W. Deviation as per log.)
12		7	9				
1		8	2				
2		9	2				Variation 8° E.
3	N. 79° W.	9	9	S. W. by S.	20°	20° W	
4		9	6				A current set, correct magnetic. } S. 45° W
5		9	9				
6		10	1				
7		10	3				
8		10	5				
9		10	2				20 miles from the time the
10		10	5				departure was taken to the end of the day.
11	N .79° W.	10	4	S. W. by S.	28°	20° W	
12		10	6				

Correct the Courses for Deviation, Variation, and Leeway, and find the Course and Distance from the given Point, and the Latitude and Longitude in by Inspection.

4. 1884, June 14th. In Longitude 176° 29′ E. The observed meridian altitude of the Sun's Lower Limb was 89° 56′ 30″, bearing North, index error 0, height of the eye 15 feet.

Required the Latitude?

5. In latitude 85° 36′, the Departure made good was 246 miles.

Required the Difference of Longitude by parallel sailing?

The Candidate should sign his name in full at the foot of every page

6. Required the Course and Distance from A to B, by Calculation on Mercator's principle ?

Lat..... of A.	37° 3′ N.	Long.....	9° 0′ W.
Lat..... of B.	36 19 S.	Long.....	56 45 W.

7. 1880, July 8th. Find the time of High Water at Poole, A.M. and P.M.

8. 1884, June 13th. At 0h. 44m. 8s. A.M. Appt. T. Ship, in latitude 66° 4′ N. Longitude 2° 42′ E. The Sun's Magnetic Amplitude was N ¼ E.

Required True Amplitude and Error of the Compass; and supposing the Variation to be 20° 15′ W. Required the Deviation of the Compass for that position of the Ship's head ?

9. 1884, June 14th. A.M. at Ship, in latitude 34° 16′ S. The observed altitude of the Sun's L.L. was 12° 43′, Height of Eye 20 feet. Time by a Chronometer 13d. 17h. 10m. 42s, which was 2m. 47s. slow for mean noon at Greenwich, on February 3rd, and on April 22nd was 1m 10s fast for mean noon at Greenwich.

Required the Longitude by Chronometer ?

ADDITIONAL FOR ONLY AND FIRST MATE.

10. 1884, September 22nd. At 3h. 15m. 36s. P.M. Mean Time at Ship, in latitude 32° 16′ S. longitude 107° 56′ W. The Sun's bearing by Compass was W by N ¾ N, the altitude of its L.L. 32° 16′ 40″ I. E.—1′ 10″, Height of Eye 21 feet.

Required the True Azimuth and Error of the Compass; and supposing the Variation to be 12° 30′ E. Required the Deviation of the Compass for that position of the Ship's head ? Both by the Sun's altitude, and also by the Time Azimuth Tables.

11. 1884, September 22nd, P.M. at Ship, Lat. by account 44° 42′ N. Long 170° 30′ W. The observed altitude of the Sun's L.L. South of the observer was 44° 44′, height of the eye 13 feet. Time by Chronometer 0h. 47m. 15s. which had been found to be 28m. 42s. fast of apparent time at Ship.

The difference of longitude made to the East was 26·5 miles, after the error on Apparent Time at Ship was determined.

Required the Latitude by the Reduction to the Meridian ?

ADDITIONAL FOR MASTER.

12. 1884, June 10th. The observed Meridian Altitude of the Star α Argus (Canopus) bearing South was 78° 42′ 15″, index error + 2′ 10″. Height of the Eye 21 feet.

Required the Latitude ?

EXAMINATION PAPER, NO. VII.

FOR SECOND MATE.

1. Multiply ·0000972 by 1547·6, by common logarithms.

2. Divide 27·41 by 8764 by common logarithms.

Note. Solve No. 1 both by common and negative indices.

3.

Hrs.	Courses.	Knts.	10ths	Winds.	Leeway.	Deviation.	Remarks, &c.
1	E.N.E.	8	7	North.	½	11° E.	
2		8	9				A point in Lat. 32° 18′ S, Long. 178° 14′ E., Bearing by compass West. Dist. 24 miles.
3		8	8				
4		8	4				
5	E. by N.	8	8	N. ½ E.	2½	17° E.	
6		8	8				
7		8	9				
8		9	6				(Ship's head E.N.E. Deviation as per log.)
9	E. ½ N.	8	6	N. by E.	1½	15° E.	
10		8	4				
11		8	6				
12		8	7				Variation 14° E.
1	E. by N. ½ N.	8	7	S.E.	¾	12° E.	
2		8	8				
3		8	5				
4		8	6				A current set. Correct magnetic. } E. ¾ N.
5	E. by S.	8	7	S. by E.	4½	24° E.	
6		8	5				
7		8	4				
8		9	6				
9	E. ½ S.	8	7	S. by E.	3¾	22° E.	18 miles from the time the departure was taken to the end of the day.
10		8	8				
11		9	3				
12		9	4				

Correct the Courses for Deviation, Variation, and Leeway, and find the Course and Distance from the given Point, and the Latitude and Longitude in, by Inspection.

4. 1884, July 22nd. In Longitude 28° 16′ W. The observed meridian altitude of the Sun's Lower Limb was 78° 29′ 10″ bearing North, index error + 8′ 10′, height of eye 16 feet.

Required the Latitude ?

5. In Latitude 45° 42′, the Departure made good was 94 miles.

Required the Difference of Longitude by parallel sailing ?

The Candidate should sign his name in full at the foot of every page.

6. Required the course and distance from A to B, by calculation on Mercator's principle ?

Lat..... of A. 35° 47′ N.	Long..... 5° 56′ W.
Lat..... of B. 20 28 S.	Long.....28 51 W.

7. 1880, July 2nd. Find the time of High Water at Bordeaux A.M. and P.M.

8. 1884, July 22nd. At 7h. 34m. P.M. Appt T. Ship in latitude 46° 22′ N, longitude 144° W. The Sun's Magnetic Amplitude was W. by N.

Required True Amplitude and Error of the Compass; and supposing the Variation to be 16° 30′ E. Required the Deviation of the Compass for that position of the Ship's head ?

9. 1884, July 23rd, P.M. at Ship, in latitude 38° 14′ N. The observed altitude of the Sun's L.L. was 42° 55′, index error + 1′ 15″, height of eye 19 feet. Time by a chronometer 23d 14h. 6m. 10s., which was 2m. 42s. fast for mean noon at Greenwich on January 10th, and on March 18th, was 1m. 16s. slow for mean noon at Greenwich.

Required the Longitude by Chronometer ?

ADDITIONAL FOR ONLY AND FIRST MATE.

10. 1884, August 29th. At 5h. 0m. P.M. Mean Time at Ship, in latitude 48° 2′ N. Longitude 40° W. The Sun's bearing by Compass was W.N.W., the altitude of its L.L. 16° 32′, Height of the Eye 14 feet.

Required the True Azimuth and Error of the Compass; and supposing the Variation to be 37° 30′ W. Required the Deviation of the Compass for that position of the Ship's head ? Both by the Sun's Altitude and by the Time Azimuth Tables.

11. 1884, August 30th, P.M. at Ship, lat by account 40° 46′ N. Long 142° 12′ E. The observed altitude of the Sun's L.L. South of the observer was 57° 24′, index error— 1′ 20″, height of eye 24 feet. Time by chronometer 30d. 0h. 29m. 24s., which had been found to be 19s. slow of apparent time at Ship.

The difference of longitude made to the West was 31 miles after the error on Apparent Time at Ship was determined.

Required the Latitude by the Reduction to the Meridian ?

ADDITIONAL FOR MASTER.

12. 1884, July 28th. The observed Meridian Altitude of the Star α Canis Majoris (Sirius) bearing South was 54° 18′ 38″ Height of the Eye 14 feet.

Required the Latitude ?

EXAMINATION PAPER, NO. VIII.

FOR SECOND MATE.

1. Multiply ·042 by 25000, by common logarithms.

2. Divide ·007616 by ·000642, by common logarithms.

3.

Hrs.	Courses.	Knts.	10ths	Winds.	Lee-Way.	Deviation.	Remarks, &c.
1	E. ¼ N.	1	5	N.N.E.	¼	23° E.	A point in lat. 38° 28′ N. Long. 28° 25′ W.
2		1	7				
3		1	9				
4		1	9				
							bearing by Compass N.E. ¼ E.
5	N. by E. ¼ E.	6	7	E.	¼	11° E.	
6		8	9				
7		8	9				
8		8	9				Dist. 37 miles.
9	S. by E. ¼ E.	5	4	E.	¾	3° W	
10		3	2				(Ship's head E. ¼ N.,
11		2	7				Deviation as per log.)
12		1	7				
1	N.E. ¼ N.	2	4	E.S.E.	1	25° E.	
2		3	1				Variation 25° West.
3		3	7				
4		2	8				
5	E.N.E.	2	1	N.	1¼	25° E.	A Current set correct magneic. } W. ¼ S.
6		1	9				
7		1	5				
8		1	5				
9	E. ¼ N.	2	6	N. by E.	1¼	23° E.	24 Miles from the time the
10		3	9				departure was taken to the
11		4	8				end of the day.
12		3	7				

Correct the Courses for Deviation, Variation, and Leeway, and find the Course and Distance from the given Point, and the Latitude and Longitude in, by Inspection.

4. 1884, August 29th. In Longitude 64° 20′ E. the observed meridian altitude of the Sun's Lower Limb was 89° 57′ 20″ bearing North index error— 1′ 20″ height of eye 17 feet.

Required the Latitude ?

5. In Latitude 22° 18′, the Departure made good was 75 miles.

Required the Difference of Longitude by parallel sailing ?

The Candidate should sign his name in full at the foot of every page.

6. Required the Course and Distance from A to B, by calculation on Mercator's principle.

Lat. of A..... 34° 21′ S.	Long..... 18° 30′E.
Lat. of B..... 40 28 N.	Long..... 78 52 W.

7. 1880, July 1st. Find the time of High Water at Penzance A.M. and P.M.

8. 1884, August 29th. At 6h. 31m. A.M., Appt T. Ship, in lat 40° 10′ S. Longitude 160° 20′ E. The Sun's Magnetic Amplitude was East.

Required True Amplitude and Error of the Compass; and supposing the Variation to be 14° 10′ E. Required the Deviation of the Compass for that position of the Ship's head?

9. 1884, August 31st, P.M. at Ship, in latitude 28° 16′ S. The observed altitude of Sun's L.L. was 26° 18′, height of eye 22 feet. Time by a chronometer 31d. 5h. 14m. 16s. which was 1m. 22s. slow for mean noon at Greenwich on March 15th, and on May 22nd was 2m. 36s. fast for mean noon at Greenwich.

Required the Longitude by Chronometer?

ADDITIONAL FOR ONLY AND FIRST MATE.

10. 1884, July 23rd. At 3h. 20m. 49s. P.M., Mean Time at Ship, in latitude 38° 14′ N., longitude 165° 35′ W. The Sun's bearing by Compass was W by S. ½ S., the altitude of its L.L. 42° 55′, index error + 1′ 15″, Height of the Eye 19 feet.

Required the True Azimuth and Error of the Compass; and supposing the Variation to be 18° 40′ E. Required the Deviation of the Compass for that position of the Ship's head; both by the Sun's altitude, and also by the Time Azimuth Tables.

11. 1884, July 22nd, P.M. at Ship, lat. by account 27° 30′ S. long 35° 30′ W. The observed altitude of the Sun's L.L. North of the observer was 42° 10′, height of eye 21 feet. Time by watch 21d. 20h. 16m. 5s. which had been found to be 3h. 52m. 12s. slow of apparent time at Ship.

The difference of longitude made to the West was 12 miles after the error on Apparent Time on Ship was determined. Required latitude by the Reduction to the Meridian.

ADDITIONAL FOR MASTER.

12. 1884, August 19th. The observed Meridian Altitude of the Star α^2 Geminorum (Castor), bearing South was 72° 14′ 10″, height of the eye 16 feet.

Required the Latitude?

EXAMINATION PAPER, NO. IX.

FOR SECOND MATE.

1. Multipty 64·2 by 286, by common logarithms.

2. Divide 675·14 by 421, by common logarithms.

3.

Hrs.	Courses	Knts.	10ths	Winds.	Lee-way.	Deviation	Remarks, &c.
1	S. 51° E.	6	1	S. 22 °W	6°	20° W	
2		6	0				A point, Krakatoa Peak. in Lat. 6° 9′ S. Long. 105 29 E.
3		5	9				
4		5	0				
5	S. 51° W.	5	6	N. 45 °W.	8°	17° E	bearing by Compass S. 51° W.
6		5	9				
7		6	5				
8		6	0				Dist 18 miles.
9	N. 68° W.	7	4	S. 45 °W.	14°	11° E.	
10		8	2				
11		9	9				(Ship' head, S. 51° E. Deviation as per log.)
12		10	5				
1	S. 68° W.	9	3	S. 28° E.	3°	17° E.	
2		8	7				Variation 3° East.
3		7	2				
4		2	8				
5	S. 84° W.	3	7	S. 23° E.	3°	17° E.	A Current set, correct magnetic } N. 45° W.
6		4	9				
7		5	1				
8		6	3				
9		6	4				
10		5	2				10 Miles from the time the departure was taken to the end of the day.
11		5	3				
12		4	4				

Correct the Courses for Deviation, Variation, and Leeway, and find the Course and Distance from the given Point, and the Latitude and Longitude in, by Inspection.

4. 1884, September 22nd. In Longitude 125° 14′ W., the observed meridian altitude of the Sun's Lower Limb was 89° 52′ 10″ bearing North, index error 0, height of eye 20 feet.

Required the Latitude?

5. In latitude 15° 42′, the Departure made good was 117 miles.

Required the Difference of Longitude by parallel Sailing?

6. Required the course and distance from A to B, by calculation on Mercator's principle?

Lat. of A.....	56°	25′ S.	Long.	68°	44′ W.
Lat. of B.....	32	48 N.	Long.	129	46 E.

7. 1880, July 8th. Find the time of High Water at Christchurch, A.M. and P.M.

8. 1884, September 22nd. At 6h. 0m. P.M., Appt. T. Ship, in latitude 48° 16′ N., longitude 24° W. The Sun's Magnetic Amplitude was W. by N. ½ N.

Required True Amplitude and Error of the Compass; and supposing the Variation to be 35° 30′ W. Required the Deviation of the Compass for that position of the Ship's head?

9. 1884, September 22nd, P.M. at Ship, in latitude 32° 16′ S. The observed altitude of the Sun's L.L. was 32° 16′ 40″, index error — 1′ 10″, height of the eye 21 feet. Time by a chronometer 22d. 10h. 32m. 6s., which was 1m. 42s. slow for mean noon at Greenwich on March 14th, and on June 24th was 1m. 42s. fast for mean noon at Greenwich.

Required the Longitude by Chronometer?

ADDITIONAL FOR ONLY AND FIRST MATE.

10. 1884, June 14th. At 8h. 23m. 30s. A.M., Mean Time at Ship, in latitude 34° 16′ S., longitude 49° 9′ E. The Sun's bearing by Compass was E. ¼ N., the altitude of its L.L. 12° 48′, height of the eye 20 feet.

Required the True Azimuth and Error of the Compass; and supposing the Variation to be 24° 10′ W. Required the Deviation of the Compass for that position of the Ship's head? Both by the Sun's Altitude and by the Time Azimuth Tables.

11. 1884, June 13th, A.M. at Ship, lat. by account 57° 33′ N., long. 9° 20′ W. The observed altitude of the Sun's L.L. South of the observer was 55° 21′, height of eye 17 feet. Time by chronometer 13d. 2h. 17m. 42s., which had been found to be 2h. 39m. 20s. fast of apparent time at Ship.

The difference of longitude made to the East was 51½ miles after the error on Apparent Time at Ship was determined.

Required the Latitude by the Reduction to the Meridian?

ADDITIONAL FOR MASTER.

12. 1884, September 6th. The observed Meridian Altitude of the Star α Canis Minoris (Procyon), bearing North, was 46° 19′ 40″, I.E. + 2′ 30″, height of the eye 25 feet.

Required the Latitude?

The Candidate should sign his name in full at the foot of every page.

EXAMINATION PAPER, NO. X.

FOR SECOND MATE.

1. Multiply 87·42 by 547·9, by common logarithms.

2. Divide 732·16 by 469, by common logarithms.

3.

Hrs.	Courses.	Knts.	10ths	Winds.	Leeway.	Deviation.	Remarks, &c.
1	W. ¼ N.	5	4	N.N.W.	¾	17° E.	A point of laud in Lat. 49° 54′N., Long. 6° 21′ W.
2		6	4				
3		5	2				
4		6	2				
5	N.E.¾E.	6	2	N. by W.	1¼	14° W.	bearing by Compass N. ¼ W.
6		6	1				
7		4	6				
8		4	1				Dist. 15 miles.
9	N.W. by N.	2	1	West.	¼	0	(Ship's head W. ¼ N., Deviation as per log.)
10		2	9				
11		2	3				
12		3	7				
1		4	0				Variation 25° West.
2	S.W. by S.	5	8	S.E.	2¼	25°E.	
3		5	6				
4		5	4				
5		5	2				
6	W.S.W.	5	1	S.	1	25°E.	A Current set correct magnetic S.E.¼E.
7		5	2				
8		5	0				
9		6	1				
10	W. by S. ¼ S.	7	3	S.	2¼	25°E.	Dist 30 miles from the time the departure was taken to the end of the day.
11		4	2				
12		3	5				

Correct the Courses for Deviation, Variation, and Leeway, and find the Course and Distance from the given Point, and the Latitude and Longitude in, by inspection.

4. 1884, October 27th. In Longitude 164° 13′ E. The observed meridian altitude of the Sun's Lower Limb was 89° 54′ 20″, bearing South, height of eye 19 feet, index error + 1′ 10″.

Required the Latitude ?

5. In Latitude 67° 15′, the Departure made good was 84 miles.

Required the Difference of Longitude by parallel sailing ?

6. Required the course and distance from A to B, by calculation on Mercator's principle ?

Lat. of A.....	20°	18′ S.	Long.....	70°	12′ W.
Lat. of B.....	30	50 N.	Long.....122		40 E.

The Candidate should sign his name in full at the foot of every page.

7. 1880, July 2nd. Find the time of High Water, at Navalo A.M. and P.M.

8. 1884, October 25th. At 5h. 27m. P.M., Appt. T. Ship, in latitude 34° 0′ N., Longitude 19° W. The Sun's Magnetic Amplitude was W. by S.

Required True Amplitude, and Error of the Compass; and supposing the Variation to be 23° 16′ W. ?

Required the Deviation of the Compass for that position of the Ship's head ?

9. 1884, October 27th A.M. at Ship, in Latitude 38° 17′ S. The observed altitude of the Sun's L.L. was 36° 13′, height of eye 16 feet. Time by a chronometer 26d. 16h. 12m. 22s., which was 1m. 28s. slow for mean noon at Greenwich on March 28th, and on July 20th was 6m. 18s. slow for mean noon at Greenwich.

Required the Longitude by Chronometer ?

ADDITIONAL FOR ONLY AND FIRST MATE.

10. 1884, May 20th. At 7h. 40m. 21s. A.M., Mean Time at Ship, in latitude 53° 47′ N., longitude 175° E. The Sun's bearing by Compass was E. by S. the altitude of its L.L. 31° 20′, height of the eye 17 feet.

Required the True Azimuth and Error of the Compass; and supposing the Variation to be 16° 30′ E. Required the Deviation of the Compass for that position of the Ship's head ? Both by the Sun's Altitude and by the Time Azimuth Tables.

11. 1884, May 19th, P.M. at Ship, in lat. by account 27° 6′ S., long. 115° 15′ W. The observed altitude of the Sun's L.L. North of the observer was 42° 16′ 20″ I.E.+2′ 15″, height of eye 18 feet. Time by chronometer 19d. 0h. 30m. 29s., which had been found to be 6m. 42s. fast of apparent time at Ship.

The difference of longitude made to the East was 24 miles after the error on Apparent Time at Ship was determined.

Required the Latitude by Reduction to the Meridian ?

ADDITIONAL FOR MASTER.

12. 1884, October 16th. The observed Meridian Altitude of the Star β Geminorum (Pollux) bearing South was 64° 18′ 10″, I.E.—3′ 17″, height of the eye 24 feet.

Required the Latitude ?

EXAMINATION PAPER, NO. XI.

FOR SECOND MATE.

1. Multiply 24000 by 32000, by common logarithms.

2. Divide 9600000 by 160, by common logarithms.

3.

Hrs.	Courses.	Knts	10ths	Winds.	Leeway.	Deviation.	Remarks, &c.
1	E. ½ S.	8	5	N. N. E.	½	21° 20′W	A point, in Lat. 12° 14′ N., Long. 179° 12′ E., bearing by Compass W. ½ N.
2		9	7				
3		9	8				
4		9	4				
5	E. by S. ½ S.	9	3	S. ½ E.	½	24° 15′ W	
6		9	2				
7		9	1				Dist. 9½ miles.
8		9	2				
9	S.S.W. ½ W.	8	4	S. E.	¾	4° E	
10		5	6				(Ship's head E. ½ S., Deviation as per log.)
11		3	2				
12		2	1				
1	N. ½ E.	2	1	E. by N.	1½	12° 40′E	
2		2	4				Variation 10° 10′ E.
3		3	6				
4		4	7				
5	E. ½ N.	6	7	N. by E.	2½	19° W	A current set correct magnetic } S ½ E.
6		8	9				
7		9	4				
8		9	9				
9	E. by N. ½ N.	9	6	North	2	13° 25′ W	
10		9	8				7½ miles during the day.
11		9	4				
12		9	3				

Correct the Courses for Deviation, Variation, and Leeway, and find the Course and Distance from the given Point, and the Latitude and Longitude, by Inspection.

4. 1884, November 28th. In Longitude 48° 0′ W. The observed Meridian Altitude of the Sun's Lower Limb was 89° 56′ 10″ bearing South, index error + 2′ 10″, height of eye 15 feet.

Required the Latitude?

5. In latitude 65° 44′, the Departure made good was 72 miles.

Required the Difference of Longitude by parallel sailing?

The Candidate should sign his name in full at the foot of every page.

6 Required the course and distance from A to B, by calculation on Mercator's principle?

A Lat.....	2°	14′ N.	Long.....	81°	16′ W.
B Lat.....	1	42 S.	Long.....188		22 E.

7. 1880, July 1st. Find the Time of High Water at Plymouth Breakwater, A.M. and P.M.

8. 1884, November 29th. At 2h. 40m. A.M., Appt. T. at Ship, in latitude 62° 14′ S. longitude 170° E. The Sun's Magnetic Amplitude was S.E. ½ S.

Required the True Amplitude and Error of the Compass; and supposing the Variation to be 25° 15′ E. Required the Deviation of the Compass for that position of the Ship's head?

9. 1884, November 28th, P.M. at Ship, in latitude 42° 17′ N. The observed altitude of the Sun's L.L. was 8° 59′, index error +4′ 10″, height of eye 19 feet. Time by a chronometer 28d. 5h. 20m. 16s., which was 6m. 14s. fast for mean noon at Greenwich on May 4th, and on September 16th, was 4m. 7s. slow for mean noon at Greenwich.

Required the Longitude by Chronometer?

ADDITIONAL FOR ONLY AND FIRST MATE.

10. 1884, April 14th. At 8h. 56m. 26s. A.M., Mean Time at Ship, in latitude 48° 14′ N., longitude 157° 31′ W. The Sun's bearing by Compass was E. by S. ½ S., altitude of its L.L. 35° 35′ 10″, I.E. — 1° 30′, height of the eye 17 feet.

Required the True Azimuth and Error of the Compass, and supposing the Variation to be 19° 40′ E. Required the Deviation of the Compass for that position of the Ship's head? Both by the Sun's Altitude and by the Time Azimuth Tables.

11. 1884, April 15, A.M. at Ship, latitude by account 35° 38′ S., longitude 170° E. The observed altitude of the Sun's L.L. North of the observer was 44° 13′, height of eye 14 feet. Time by chronometer 15d. 0h. 16m. 24s., which had been found to be 30m. 16s. fast of apparent time at Ship.

The difference of longitude made to the East was 58 miles after the error on Apparent Time at Ship was determined.

Required the Latitude by the Reduction to the Meridian?

ADDITIONAL FOR MASTER.

12. 1884, November 25th. The observed Meridian Altitude of the Star α Leonis (Regulus) bearing North was 22° 18′ 10″, height of the eye 28 feet.

Required the Latitude?

EXAMINATION PAPER, NO. XII.

FOR SECOND MATE.

1. Multiply 651·48 by ·00000417, by common logarithms.

2. Divide ·0000478 by ·0000021 by common logarithms.

3. *Note.* Solve 1 and 2 by both common and negative indices.

Hrs.	Courses.	Knts.	10ths	Winds.	Lee-way.	Devia-tion.	Remarks, &c.
1	S. 79° W.	6	4	N. 34° W.	3°	20° W.	A point of land, Cape Clear, in Lat. 51° 26′ N., Long 9° 29′ W. bearing by Compass S. 73° E.
2		6	2				
3		6	4				
4		6	0				
5	N. 68° W.	5	6	North.	6°	25° W.	
6		5	2				
7		5	2				Dist. 15 miles.
8		5	0				
9	S. 56° W.	4	2	N. 56° W.	11°	11° W.	(Ship's head S. 79° W.,
10		4	6				Deviation as per log.)
11		4	2				
12		4	0				
1	N. 23° W.	4	0	West	17°	14° W.	Variation 28° W.
2		4	0				
3		3	6				
4		3	4				
5	N. 34° W.	3	2	S. 79° W.	23°	20° W.	A current set correct magnetic. } N. 28° E.
6		3	4				
7		3	4				
8		3	0				
9	N. 68° W.	2	8	S. 45° W.	25°	25° W.	24 miles from the time the
10		2	2				departure was taken to the
11		2	0				end of the day.
12		2	6				

Correct the Courses for Deviation, Variation, and Leeway, and find the Course and Distance from the given Point, and the Latitude and Longitude in, by Inspection.

4. 1884, December 24th, in Longitude 179° 0′ E. The observed Meridian Altitude of the Sun's Lower Limb was 89° 57′ 10″ bearing North, index error 0, height of the eye 18 feet.

Required the Latitude ?

5. In latitude 1° 31′, the Departure made good was 165 miles.

Required the difference of Longitude by parallel sailing ?

The Candidate should sign his name in full at the foot of every page.

6. Required the course and distance from A to B by calculation on Mercator's principle?

Lat. of A.....	8°	18′ N.	Long. A.....	84°	25′ W.
Lat. of B.....	1	7 S.	Long. B.....	140	6 E.

7. 1880, July 8th. Find the Time of High Water at Bembridge Point, A.M. and P.M.

8. 1884, Dec. 22nd. At 11h. 22m. P.M., Appt. T. Ship, in latitude 64° 15′ S., longitude 96° W. The Sun's Magnetic Amplitude was S. ¼ E.

Required True Amplitude and Error of the Compass; and supposing the Variation to be 32° 0′ E. Required the Deviation of the Compass for that position of the Ship's head?

9. 1884, December 24th, A.M. at Ship, in latitude 38° 14′ S. The observed Altitude of the Sun's L.L. was 43° 56′, height of eye 23 feet. Time by a Chronometer 23d. 15h. 16m. 4s., which was 2m. 10s. slow for mean noon at Greenwich, July 10th, and on October 16th was 1m. 55s. fast for mean noon at Greenwich.

Required the Longitude by Chronometer?

ADDITIONAL FOR ONLY AND FIRST MATE.

10. 1884, March 19th. At 4h. 5m. 42s. P.M., Mean Time at Ship, in latitude 32° 4′ N., longitude 173° W. The Sun's bearing by Compass was W. by S. ½ S., the altitude of its L.L. 25° 15′ 40″, height of the eye 19 feet.

Required the True Azimuth and Error of the Compass; and supposing the Variation to be 12° 10′ E. Required the Deviation of the Compass for that position of the Ship's head? Both from the Altitude and also from the Azimuth Tables.

11. 1884, March 20th, A.M. at Ship, latitude by account 37° 57′ N., long. 178° E. The observed Altitude of the Sun's L.L. South of the observer was 51° 16′ 15″, index error — 1′ 15″, height of eye 19 feet. Time by watch 19d. 23h. 32m. 2s., which had been found to be 2m. 4s. fast of Apparent Time at Ship.

The difference of Longitude made to the East was 38 miles after the error on Apparent Time at Ship was determined.

Required the Latitude by Reduction to the Meridian.

ADDITIONAL FOR MASTER.

12. 1884, December 17th. The observed Meridian Altitude of the Star α Virginis (Spica) bearing South was 68° 18′ 10″, height of the eye 22 feet.

Required the Latitude?

ANSWERS TO PAPER I.

No. *Question.*

1. Multiplication, Log. 5·871481. Product 235196·74.

2. Division ..... Log. 0·425060. Quotient 2·661.

3. Day's Work } S 32° W 18; S 16° W 29; S 2° W 24; S 30° E 24;
   True Courses } S 33° E 25; S 73° W 21; N 71° W 17; S 25° W 25;
   Diff. lat. 132·3 S. Dep. 39·5 W. Lat. in. 36° 33′ S
   Long. in 114° 17½′ E. Course S 16½° W. Dist. 137½ mls.
   By logs. Diff. long. 48·49. Course S 16° 37′ W. Dist. 138·1 mls.

4. Meridian } ... A.T.G. 8d 1h 43m 20s. Red. dec. 22° 50′ 58″ S.
   Altitude } ... True alt. 52° 31′ 17″ S. Latitude 14° 37′ 45″ N.

5. Parallel } ... Log. 2·236391. Diff. long. 172·3
   Sailing }

6. Mercator } ... Diff. lat. 104 S. Mer. Diff. lat. 162 Diff. long. 185 W.
   Sailing } ... Tan. 10·057657. Log. dist. 2·198352.
   Course S 48° 48′ W. Distance 157·9 mls.
   To seconds of arc. Course S 48° 47′ 32″ W. Distance 157·9. mls.

7. Tides..... Constant—0h 29m. 11h 35m A.M. No P.M. tide.

8. Amplitude ... A.T.G. 1d 20h 43m 4s. Red. dec. 22° 57′ 38″ S.
   Sin. 9·720209. True amp. E 31° 40′ S.
   Error 35° 50′ W. Deviation 12° 0′ W.
   To seconds of arc. Deviation 12° 0′ 12″ W.

9. Chronometer...Daily rate 1s gaining.
   M.T.G. 2d 5h 11m 11s. P.D. 67° 4′ 14″
   Eq. T. + 4m 12·67s. True alt. 41° 56′ 43″
   Log. 9·305070. H.A. 3h 33m 35s.
   Longitude 23° 20′ 45″ West.

10. Azimuth .....M.T.G. 7d 20h 16m 18s. P.D. 74° 52′ 26″.
    True alt. 41° 5′ 4″. Sin. 9·798478.
    True az. 77° 55′ East. Error 9° 16′ W.
    Deviation 18° 14′ East. To seconds of arc 18° 14′ 35″ E.
    By Azimuth Tables, Deviation 18° 27′ East.

11. Reduction.....A.T.G. 8d 0h 48m 54s. T. from N. 24m 34s
    Red. dec. 15° 3′ 50″. True alt. 59° 15′ 41″.
    Log. 3·728668. Lat. 15° 4′ N.
    To seconds of arc 15° 4′ 9″ N.

12. Star .....True alt. 47° 47′ 45″ N. Lat. 62° 20′ 10″ N.

ANSWERS TO PAPER II.

No. *Question.*

1. Multiplication. Log. 3·932640. Product 8563·27.

2. Division. .....Log. 1·452773. Quotient 28·36.

3. Day's Work / True Courses } S 63° W, 17; S 86° E, 21; S 52° E, 29; S 76° E, 24; N 85° E, 14; S 74° W, 12; N 72° W, 28; S 14 E, 34.
Diff. lat. 74·8 S. Dep. 27·4 E. Lat. in 49° 9′ N.
Long. in 178° 32′ W. Course S 20° E. Dist. 80 miles.
By logs D. Long. 42·42. Course S 20° 7′ E. Distance 79·66 miles.

4. Meridian / Altitude. .....A.T.G. 8d 16h 38m 4s. Red. dec. 14° 51′ 19″ S.
.....True alt. 61° 24′ 46″ N. Lat. 48° 26′ 33″ S.

5. Parallel Sailing. .....Log. 2·444776. Diff. Long. 278·5

6. Mercator Sailing .....Diff. lat. 157° N. Mer. diff. lat. 284°.
.....Diff. long. 728° E.
Tan. 10·408813. Log dist. 2·635369.
Course N 68° 41′ E. Distance 431·9 miles.
To seconds of arc Course 68° 41′ 19″. Dist. 432.

7. Tides.....Constant — 0h 2m. 11h 45m A.M. No P.M.

8. Amplitude. ...A.T.G. 8d 2h 31m. Red. dec. 15° 2′ 30″ S.
Sin. 9·732273. True amp. W 32° 40′ S.
Error 25° 10′ W. Deviation 20° 8′ E.
To seconds of arc, Deviation 20° 8′ 47″ E.

9. Chronometer...Daily rate 1·32s Losing.
M.T.G. 7d 20h 16m 14s. P.D. 74° 52′ 26″.
Eq. T. + 14m 23·72s. True alt. 41° 5′ 4″.
Log 9·248256. H.A. 20h 40m 54s.
Longitude 9° 46′ East.

10. Azimuth .....M.T.G. 2d 5h 11m 12s. P.D. 67° 4′ 14″.
True alt. 41° 56′ 43″. Sin. 9·824570.
True az. N 83° 47′ W. Error 16° 17′ W.
Deviation 10° 47′ W. By Azimuth Tables 11° 8′ W.
Working to seconds of arc, Dev. 10° 44′ 44″ W.

11. Reduction.....A.T.G. 2d 1h 0m 30s. Time from noon 12m 22s.
Red. dec. 22° 56′ 41″ S. True alt. 59° 29′ 51″ S.
Log 3·123611. Nat. num. 1329.
Mer. Zen. dist. 30° 21′ N. Lat. 7° 24′ N.
To Seconds of arc, Lat. 7° 24′ 27″ N.

12. Star .....True alt. 32° 12′ 41″ S. Lat. 0° 2′ 30″ S.

ANSWERS TO PAPER III.

No. *Question*

1. Multiplication. Log. 9·429429. Product 2688000000.

2. Division.....Log. 2·141740. Quotient 138·59.

3. Day's Work / True Courses } N 18° E, 17; S 82° E, 20; S 85° E, 18; S 52° E, 21; N 24° E, 27; N 11° W, 19; N 49° W, 22; N 14° E, 9; Diff. lat. 65·4 N. Dep. 52·5 E. Lat. in 55° 12′ N. Long. in 1° 25¼′ E. Course N 39° E. Dist. 83¼ miles. By Logs. Diff. long. 90·74. Course 38° 45′. Dist. 88·36. miles.

4. Meridian / Altitude } .....A.T.G. 19d. 14h. 8m. 0s. Red. dec. 0° 2′ 28″ S. .....True alt. 51° 24′ 27″ S. Lat. 38° 33′ 5″ N.

5. Parallel Sailing } .....Log. 2·386041. Diff. long. 243·2.

6. Mercator's Sailing } ...Diff. lat. 53° S. Mer. diff. lat. 8·2. Diff. long. 0° 47′ E. ...Tan. 9·758284. Log dist. 1·785946. Course S. 29° 49′ E. Distance 61·09 miles. To Seconds of Arc, Course S. 29° 49′ 12″ E. Dist. 61·09 miles.

7. Tides.....Constant + 0h. 4m. 0h. 11m. P.M. No A.M.

8. Amplitude.....A.T.G. 19d. 16h. 22m. 12s. Red. dec. 0° 0′ 12″ S. True amp. E. 0° 0′. Error 2° 49′ E. Deviation 13° 29′ E.

9. Chronometer...Daily rate 1·5s. gaining M.T.G. 19d. 15h. 37m. 59s. P.D. 90° 1′ 6″. Eq. T. + 7m. 31·19s. True alt. 25° 25′ 34″. Log 9·391953. H.A. 3h. 58m. 11s. Longitude 173° 4′ 15″ West.

10. Azimuth .....M.T.G. 28d. 15h. 11m. 9s. P.D. 66° 34′ 38″ True alt. 44° 6′ 41″. Sin. 9·836231. True az. S. 93° 24′ E. Error 20° 16′ W. Deviation 0° 6′ W. By Azimuth Tables 0° 26′ W. To Seconds of Arc. Deviation 0° 5′ 16″ W.

11. Reduction ...A.T.G. 23d. 2h. 47m. 58s. T. from N. 27m. 30s. Red. dec. 23° 25′ 56″ S. True alt. 59° 10′ 25″ N. Log 3·590492. Nat. num. 3895 Lat. 53° 50′ S. To Seconds of Arc. Lat 53° 49′ 13″ S.

12. Star .....True alt. 52° 5′ 31″ N. Lat 21° 38′ 6″ S.

ANSWERS TO PAPER IV.

No. *Question.*

1. Multiplication. Log 4·667470. Product 46501·88.

2. Division .....Log 1·376449. Quotient 23·79.

3. Day's Work / True Courses } S 16° W, 21; S 49° E, 56; S 59° E, 61; S 43° E, 69; S 87° E, 68; S 27° E, 25; N 38° W, 5; N 20° W, 23;
Diff. lat. 139·2 S. Dep. 204·1 E. Lat. in 50° 3′ S.
Long. in 175° 43′ W. Course S 55½ E. Dist. 248 miles.
By logs. Diff. long. 310·4. Course 55°42′. Dist. 247 miles.

4. Meridian / Altitude. } .....A.T.G. 13d 17h 53m 12s. Red. dec. 9° 33′ 56″ N.
.....True alt. 90° 6′ 34″ S. Latitude 9° 27′ 22 ″N.

5. Parallel Sailing } .....Log. 2·713078. Diff. Long. 516·5.

6. Mercator's Sailing } ...Diff. lat. 1244 N. M.D.L. 2662. Diff. Long. 1724 E.
...Tan. 9·811329. Log. Dist. 3·170901.
Course N 32° 56′ E. Distance 1482 miles.
To seconds of arc, Course 32° 55′ 42″. Dist. 1482 miles.

7. Tides.....Constant — 0h 46m, 11h 18m A.M. 11h 58m P.M.

8. Amplitude.....A.T.G. 14d 19h 17m 40s. Red. dec. 9° 56′ 38″ N.
Sin. 9·528209. True amp. W 19° 43′ N.
Deviation 8° 46′ W. To seconds 8° 46′ 12″ W.

9. Chronometer...Daily rate 4·8s gaining.
M.T.G. 14d 11h 26m 51s. P.D. 80° 10′ 24″.
Eq. T. + 0m 0·02s. True alt. 35° 44′ 20″.
Log. 9·181655. H.A. 3h 3m 34s.
Longitude 125° 49′ 15″ West.

10. Azimuth .....M.T.G. 28d 5h 30m 1s. P.D. 111° 28′ 57″
True alt. 9° 9′ 28″. Sin. 9·622689.
True az. S 49° 36′ W. Error 1° 47′ E.
Dev. 13° 7′ E. By Azimuth Tables Dev. 13° 32′ E.
To seconds of arc, Dev. 13° 7′ 49″ E.

11. Reduction.....A.T.G. 29d 1h 48m 28s. T. from N. 35m 32s.
Red. dec. 21° 37′ 19″ S. True alt. 56° 21′ 38″ N.
Log 3·810356. Nat. num. 6462.
Lat. 54° 35′ S. To seconds, Lat. 54° 35′ 14″ S.

12. Star .....True alt. 29° 8′ 36″. Lat. 14° 58′ 44″ South.

ANSWERS TO PAPER V.

No. *Question.*

1. Multiplication. Log. 3·977909 Product. 9504·07.

2. Division .....Log. 9·100514. Quotient ·126.

3. Day's Work / True Courses } S 76° E, 20; N 12° E, 48·3; N 14° W, 29·8; N 27° W, 14·9
S 86° E, 44·2; S 70° E, 15·2; S 49° E, 22·1; N 19 E, 16.
Diff. lat. 76·9 N. Dep. 95·7 E. Lat. in 58° 59′ N.
Long. in 1° 0′ E. Course N 51° E. Dist. 123 miles.
By Logs Diff. Long. 182·3. Course 51° 13′. Dist. 122·8.

4. Meridian / Altitude. } .....A.T.G. 20d 12h 17m 4s. Red. dec. 20° 13′ 37″ N.
.....True alt. 54° 28′ 56″ S. Lat. 55° 44′ 41″ N.

5. Parallel / Sailing. } .....Log. 2·993496. Diff. Long. 985·1.

6. Mercator's / Sailing. } ...Diff. lat. 201 S. M.D.L. 265. Diff. Long. 3779 W.
...Tan. 11·154131. Log dist. 3·457809.
Course S 85° 59′ W. Distance 2870 miles.
To seconds 85° 59′ 19″. Dist. 2873 miles.

7. Tides.....Constant + 0h 50m., 0h 2m A.M. 0h 37m P.M.

8. Amplitude.....A.T.G. 20d 3h 45m 4s. Red. dec. 20° 9′ 15″ N.
Sin. 9·697231. True amp. E 29° 52′ N.
Error 3° 53′ E. Deviation 8° 52′ West.
To seconds of arc, Deviation 8° 52′ 28″ West.

9. Chronometer...Daily rate 2·63 Losing.
M.T.G. 20d 5h 13m 8s. P.D. 110° 10′ 0″.
Eq. T. — 3m 40·03s. True alt. 24° 21′ 46″.
Log 9·287352. H.A. 3h 28m 57s.
M.T.S. 20d 3h 25m 17s.
Longitude 26° 57′ 45″ West.

10. Azimuth .....M.T.G. 26d 16h 22m 42s. P.D. 77° 4′ 45″.
True alt. 36° 24′ 1″. Sin. 9·813741.
True az. S 98° 44′ E. Error 22° 48′ W.
Deviation 1° 32′ E. To seconds of arc 1° 32′ 29″ E.
By Azimuth Tables 1° 52′ E.

11. Reduction.....A.T.G. 25d 1h 34m 40s. T. from N. 2m. 24s.
Red. dec. 12° 22′ S. True alt. 48° 2′ 45″.
Log 1·668073. Nat num. 47.
Lat. 29° 35′ N. To seconds of arc 29° 35′ 1″ N.

12. Star .....True alt. 64° 22′ 25″ S. Lat. 17° 17′ 12″ N.

ANSWERS TO PAPER VI.

No. *Question.*

1. Multiplication. Log 4·666416, 6·666416. Product ·000004689.

2. Division.....Log 2·892223. Quotient 780·23.

3. Day's Work / True Courses } N 11° W, 22; S 88° W, 18; S 56° W, 15; S 44° E, 17·9; N 81° W, 33; N 71° W, 81; N 63° W, 21; S 53 W, 20.
Diff. lat. 51·9 N. Dep. 150·5 W. Lat. in 13° 34′ S.
Longitude in 132° 12′ W. Course N 71° W. Dist. 159 miles.
By Logs Diff. Long. 155·1. Course 70° 58′. Dist. 159·1.

4. Meridian / Altitude } .....A.T.G. 13d 12h 14m 4s. Red. dec. 23° 16′ 57″ N.
.....True alt. 90° 8′ 28″ N. Lat. 23° 25′ 25″ N.

5. Parallel / Sailing } .....Log 3·506032. Diff. Long. 3207.

6. Mercator's / Sailing } ...D. Lat. 4402 S. M.D.L. 4738. D. Long. 2865 W.
...Tan. 9·781580. Log dist. 3·711346
Course S 31° 10′ W. Distance 5145 miles.
To seconds of arc, Course 31° 9′ 39″. Dist. 5144.

7. Tides.....Constant — 2h 31m. 9h 36m A.M. 9h 54m P.M.

8. Amplitude.....A.T.G. 12d 12h 33m 20s. Red. dec. 23° 13′ 54″ N.
Sin. 9·987844. True amp. E 76° 30′ N.
Deviation 30° 56′ E. To seconds 30° 56′ 48″ E.

9. Chronometer...Daily rate 8s gaining.
M.T.G. 13d 17h 6m 54s. P.D. 118° 17′ 30″.
Eq. T. — 0m 0·40s. True alt. 12°.50′ 20″.
Log 9·315933. H.A. 20h 23m 30s.
M.T.S. 13d 20h 23m 30s.
Longitude 49° 9′ East.

10. Azimuth. .....M.T.G. 22d 10h 27m 20s. P.D. 89° 53′ 2″.
True alt. 32° 25′ 34″. Sin. 9·739295.
True az. 66° 33′ W. Error 3° 46′ E.
Deviation 8° 44′ W. By Azimuth Tables Dev. 8° 47′ W.
By working to seconds of arc. Dev. 8° 43′ 9″ W.

11. Reduction.....A.T.G. 22d 11h 42m 19s. T. from N. 20m 19s.
Red. dec. 0° 8′ 1″ S. True alt. 44° 55′ 33″ S.
Log 3·445516. Nat. num. 2789.
M.Z.D. 44° 50′ N. Lat. 44° 42′ N.
To seconds of arc, Lat. 44° 42′ 52″ N.

12. Star .....True alt. 78° 39′ 43″ S. Lat. 41° 17′ 56″ S.

ANSWERS TO PAPER VII.

No. *Question.*

1. Multiplication. Log 9·177825, $\bar{1}$·177825. Product ·1504.

2. Division.....Log 7·495207. Quotient ·003128.

3. Day's Work } S 65° E, 24; S 82° E, 34·8; S 45° E, 36·1; S 50° E, 34·8;
   True Courses. } S 89° E, 34·6; N 89° E, 35·2; N 89° E, 36·2; S 84° E, 18.
   Diff. lat. 63·8 S. Dep. 232·0 E. Lat. in 33° 22′ S.
   Long. in 177° 11′ W.. Course S 75° E. Dist. 241 miles.
   By logs. D. Long. 276·1. Course 74° 37′. Dist. 240·5.

4. Meridian } .....A.T.G. 22d 1h 53m 4s. Red. dec. 20° 8′ 34″ N.
   Altitude. } .....True alt. 78° 43′ 55″ N. Lat. 3° 52′ 29″ N.

5. Parallel } .....Log. 2·129014. Diff. Long. 134·6 miles.
   Sailing. }

6. Mercator's } ...D. Lat. 3375 S. M.D.L. 3557. D. Long. 1375 W.
   Sailing. } ...Tan. 9·587219. Log dist. 3·558512.
   Course S 21° 8′ W. Dist. 3618 miles.
   To seconds 21° 8′ 5″. Dist. 3618.

7. Tides.....Constant + 3h 3m. 2h 15m A.M. 2h 50m P.M.

8. Amplitude.....A.T.G. 22d 17h 10m 0s. Red. dec. 20° 0′ 44″ N.
   Sin. 9·695524. True amp. W 29° 44′ N.
   Error 18° 29′ E. Deviation 1° 59′ E.
   To seconds of arc, 1° 58′ 55″ East.

9. Chronometer...Daily rate 3·5s. losing.
   M.T.G. 23d 14h 14m 53s. P.D. 70° 10′ 10″.
   Eq. T. + 6m 14·17s. True alt. 48° 6′ 49″.
   Log 9·254299. H.A. 3h 20m 35s.
   M.T.G. 23d 3h 26m 49s.
   Longitude 162° 1′ West.

10. Azimuth .....M.T.G. 29d 7h 40m 0s. P.D. 80° 59′ 4″.
    True alt. 16° 41′ 7″. Sin. 9·829847.
    True az. N. 95° 5′ W. Error 27° 35′ W.
    Deviation 9° 55′ E. To seconds 9° 54′ 54″ E.
    By Azimuth Tables 9° 54′ E.

11. Reduction.....A.T.G. 29d 14h 58m 51s. T. from N. 27m 39s.
    Red. dec. 8° 54′ 23″. True alt. 57° 33′ 12″ S.
    Log. 3·735540. Nat. num. 5439.
    Mer. Z.D. 57° 33′ N. Lat. 40° 46′ N.
    To seconds of arc, Lat. 40° 46′ 4″ N.

12. Star .....True alt. 54° 14′ 8″ S. Lat. 19° 12′ 17″ N.

ANSWERS TO PAPER VIII.

No. *Question.*

1. Multiplication. Log 3·021189. Product 1050.

2. Division. .....Log 8·925808, $\overline{2}$·925808. Quotient ·0843.

3. Day's Work } S. 49° W, 37; N 85° E, 7; N 8° W, 33·4; S 36° E, 18;
   True Courses. } N 28° E, 12; N 82° E, 7; S 81° E, 15; S 59° W, 24.
   Diff. lat. 3·9 S. Dep. 8·4 W. Lat. in 38° 24′ N.
   Long. in 28° 36′ W. Course S 65° W. Dist. 9 miles.
   By logs. Diff. Long. 10·72. Course 65° 5′. Dist. 9·263.

4. Meridian } .....A.T.G. 28d 19h 42m 40s. Red. dec. 9° 11′ 40″ N.
   Altitude. } .....True alt. 90° 7′ 49″. Lat. 9° 19′ 29″ N.

5. Parallel } .....Log 1·908821. Diff. long. 81·06.
   Sailing. }

6. Mercator's } ...D. Lat. 4489 N. M.D.L. 4856. D. Long. 5542 W.
   Sailing. } ...Tan. 10·057388. Log dist. 3·833181.
   Course N. 48° 46′ W. Distance 6811 miles.
   To seconds, Course 48° 46′ 28″. Dist. 6812.

7. Tides.....Constant — 1h 18m. 10h 51m A.M. 11h 26m P.M.

8. Amplitude.....A.T.G. 28d 7h 49m 40s. Red. dec. 9° 22′ 17″ N.
   Sin. 9·328335. True amp. E 12° 18′ N.
   Error 12° 18′ W. Deviation 26° 28′ W.
   To seconds of arc, Deviation 26° 28′ 11″ W.

9. Chronometer...M.T.G. 31d 5h 5m 46s. P.D. 98° 20′ 1″
   Eq. T. — 0m 2·55s. True alt. 26° 27′ 28″
   Log 9·311733. H.A. 3h 35m 22s.
   M.T.S. 31d 3h 35m 19s.
   Longitude 22° 36′ 45″ West.

10. Azimuth .....M.T.G. 23d 14h 23m 9s. P.D. 70° 10′ 16″
    True alt. 43° 6′ 49″. Sin. 9·815098.
    True az. S 81° 35′ W. Error 5° 39′ E.
    Deviation 8° 1′ W. By Azimuth Tables 8° 25′ W.
    To seconds of arc 8° 0′ 7″ W.

11. Reduction.....A.T.G. 22d 2h 29m 29s. T. from N. 7m 29s.
    Red. dec. 20° 8′ 16″ N. True alt. 42° 20′ 18″ N.
    Log 2·647296. Nat. num. 444.
    M.Z.D. 47° 38′ S. Latitude 27° 30′ S.
    To seconds of arc, Lat. 27° 29′ 22″ S.

12. Star .....True alt. 72° 9′ 55″ S. Latitude 49° 58′ 22″ N.

ANSWERS TO PAPER IX.

No. *Question.*

1. Multiplication. Log 4·180447. Product 15151·18.

2. Division. .....Log 0·205112. Quotient 1·604.

3. Day's Work } N 34° E, 18; S 74° E, 23; S 63° W, 24; N 40° W, 36;
   True Courses } N 89° W, 28; N 73° W, 41·3; N 42° W, 10;
   Diff. lat. 45·3 N. Dep. 86·5 W. Lat. in 5° 24′ S.
   Long. in 104° 2′ E. Course N 62° W. Dist. 97½ miles.
   By logs. Diff. long. 86·94. Course 62° 22′. Dist. 97·67.

4. Meridian } .....A.T.G. 22d 8h 20m 56s. Red. dec. 0° 4′ 22″ S.
   Altitude } .....True alt. 90° 8′ 45″ N. Lat. 0° 0′ 57″ S.

5. Parallel Sailing } .....Log 2·084699. Diff. long. 121·5.

6. Mercator's Sailing } ...D. Lat. 5348 N. M.D.L. 6198. D. Log 9690 W.
   ...Tan. 10·194072. Log dist. 3·996787.
   Course N 57° 24′ W. Distance 9926 miles.
   To Seconds of Arc, Course 57° 23′ 45″. Dist. 9925.

7. Tides.....Constant— 2h 41m. 9h 26m A.M. 9h 44m P.M.

8. Amplitude.....A.T.G. 22d 7h 36m 0s. Red. dec. 0° 4′ 1″ S.
   Sin. 7·242531. True amp. W 0° 6′ S.
   Error 16° 59′ W. Deviation 18° 31′ E.
   To Seconds of Arc, Deviation 18° 31′ 28″ E.

9. Chronometer...Daily Rate 2s. gaining.
   M.T.G. 22d 10h 27d 23s. P.D. 89° 53′ 2″.
   Eq. T.—7m 39·52s. True alt. 32° 25′ 33″.
   Log 9·263808. H.A. 3h 22m 57s.
   M.T.S. 22d 3h 15m 17s. Long. 108° 1′ 30″ W.

10. Azimuth .....M.T.G. 13d 17h 6m 54s. P.D. 118° 17′ 30″.
    True alt. 12° 50′ 20″. Sin. 9·623932.
    True az. 49° 45′ W. Error 31° 49′ W.
    Dev. 7° 39′ W. By Azimuth Tables 7° 28′ W.
    To Seconds of Arc, Dev. 7° 38′ 13″ W.

11. Reduction.....A.T.G. 13d 0h 19m 8s. T. from N. 18m 12s.
    Red. dec. 23° 15′ 25″ N. True alt. 55° 32′ 8″ S.
    Log 3·191448. Nat. num. 1554.
    M.Z.D. 34° 19′ N. Lat. 57° 34′ N.
    To Seconds of Arc, Lat. 57° 33′ 49″ N.

12. Star .....True alt. 46° 16′ 20″ N. Lat. 38° 12′ 32″ S.

ANSWERS TO PAPER X.

No. *Question.*

1. Multiplication. Log 4·811805. Product 20502·42.

2. Division.....Log 0·193482. Quotient 1·561.

3. Day's Work / True Courses. } S 14° E, 15; S 79° W, 23·2; N 29° E, 21; N 53° W, 15; S 62° W, 22; S 79° W, 21·4; N 82° W, 15; S 76° E, 30.
Diff. lat. 11·2 S. Dep. 47·1 W. Lat. in 49° 43′ N.
Long. in 7° 34′ W. Course S 77° W. Dist. 49 miles.
By Logs. D. Long. 72·97. Course 76° 38′. Dist. 48·45.

4. Meridian / Altitude. } .....A.T.G. 26d 13h 3m 8s. Red. dec. 12° 52′ 14″ S.
.....True alt. 90° 7′ 21″ S. Latitude 12° 59′ 35″ S.

5. Parallel / Sailing. } .....Log 2·336893. Diff. Long. 217·2.

6. Mercator's / Sailing. } ...D. Lat. 3063 N. M.D.L. 3185. D.L. 10028 W.
...Tan. 10·498105. Log dist. 4·005210.
Course N 72° 23′ W. Distance 10121 miles.
To seconds of arc, Course 72° 22′ 47″. Dist. 10119.

7. Tides.....Constant — 0h 5m. 11h 42m A.M. No. P.M.

8. Amplitude.....A.T.G. 25d 6h 43m 0s. Red. dec. 12° 26′ 23″ S.
Sin. 9·914477. True amp. W 15° 3′ S.
Error 3° 48′ W. Deviation 19° 28′ E.
To seconds of arc, Dev. 19° 27′ 23″ E.

9. Chronometer...Daily rate 2·5s losing.
M.T.G. 26d 16h 22m 42s. P.D. 77° 4′ 45″.
Eq. T. — 16m 2·66s. True alt. 36° 24′ 1″.
Log 9·324588. H.A. 20h 21m 9s.
Longitude 55° 36′ East.

10. Azimuth .....M.T.G. 19d 8h 0m 21s. P.D. 70° 0′ 55″.
True alt. 31° 30′ 19″. Sin. 9·812037.
True az. S 80° 53′. Error 2° 8′ W.
Deviation 18° 38′ W. By Azimuth Tables Dev. 18° 57′ W.
To seconds of arc, Dev. 18° 37′ 50″ W.

11. Reduction.....A.T.G. 19d 8h 6m 23s. T. from N. 25m 23s.
Red. dec. 19° 59′ 6″ N. True alt. 42° 29′ 17″.
Log 3·709666. Nat. num. 5125.
M.Z.D. 47° 7′ S. Latitude 27° 8′ S.
To seconds of arc, Latitude 27° 7′ 39″ S.

12. Star .....True alt. 64° 9′ 36″ S. Lat. 54° 8′ 25″ N.

ANSWERS TO PAPER XI.

No. *Question.*

1. Multiplication. Log 8·885361. Product 768 000 000.

2. Division .....Log 4·778151. Quotient 60 000.

3. Day's Work } N 84° E, 9·3 ; N 87° E, 37·4 ; N 87° E, 36·8 ; S 51° W, 19·3.
   True Courses. } N 14° E, 12·8 ; S 82° E, 34·9 ; S 88° E, 38·1 ; S 7° W, 7·8.
   Diff. lat. 8·8 S. Dep. 143·3 E. Lat. in 12° 5′ N.
   Long. in 178° 21′ W. Course S 86½° E. Dist. 144 miles.
   By Logs. D. Long. 146·6. Course 86° 29′. Dist. 143·5.

4. Meridian } .....A.T.G. 28d 3h 12m 0s. Red. dec. 21° 27′ 53″ S.
   Altitude. } .....True alt. 90° 10′ 46″ S. Lat. 21° 38′ 39″ S.

5. Parallel Sailing. } .....Log 2·243507. Diff. long. 175·2.

6. Mercator's Sailing. } ...D. Lat. 236 S. M.D.L. 236. D.L. 8422 W.
   ...Tan. 11·552503. Log dist. 3·926971.
   Course S 88° 24′ W. Distance 8452 miles.
   To seconds of arc, Course 88° 23′ 42″. Dist. 8426.

7. Tides.....Constant — 0h 6m. 11h 58m A.M. No. P.M.

8. Amplitude.....A.T.G. 28d 3h 20m 0s. Red. dec. 21° 27′ 56″ S.
   Sin. 9·895166. True amp. E 51° 56′ S.
   Error 1° 8′ E. Deviation 24° 7′ West.
   To seconds of arc, Dev. 24° 6′ 30″ West.

9. Chronometer...Daily rate 4·6s Losing.
   M.T.G. 28d 5h 30m 0s. P.D. 111° 28′ 57″.
   Eq. T. — 11m 34·39s. True alt. 9° 9′ 27″.
   Log 9·312730. H.A. 3h 35m 38s.
   M.T.S. 28d 3h 24m 4s. Long 31° 29′ W.

10. Azimuth .....M.T.G. 14d 7h 26m 30s. P.D. 80° 13′ 59″.
    True alt. 35° 44′ 20″. Sin. 9·702469.
    True az. S 60° 32′ E. Error 15° 24′ E.
    Dev. 4° 16′ W. By Azimuth Tables 4° 45′ W.
    To seconds of arc, Dev. 4° 15′ 25″ W.

11. Reduction.....A.T.G. 14d 12h 30m 0s. T. from Noon 10m 0s.
    Red. dec. 9° 50′ 35″ N. True alt. 44° 24′ 53″ N.
    Log 2·882053. Nat. num. 762.
    M.Z.D. 45° 31′ S. Latitude 35° 40′ S.
    To seconds of arc, Lat. 35° 40′ 52″ S.

12. Star .....True alt. 22° 11′ 6″ N. Latitude 55° 17′ 15″ South.

ANSWERS TO PAPER XII.

No. *Question.*

1. Multiplication. Log 7·434004, or Log 3·434004. Product ·002716.

2. Division.....Log 1·852642. Quotient 22·52.

3. Day's Work } S 59° W, 15 ; S 28° W, 25 ; S 58° W, 21 ; S 6° W, 17 ;
   True Courses. } N 48° W, 15 ; N 59° W, 13 ; S 84° W, 9·6 ; North 24.
   Diff. lat. 19° 6′ S. Dep. 75·0 W. Lat. in 51° 6′ N.
   Long. in 11° 28′ W. Course S 75° W. Dist. 77 miles.
   By logs. Diff. long. 119·9. Course 75° 21′. Dist. 77·5.

4. Meridian } .....A.T.G. 23d 12h 4m 0s. Red. dec. 23° 25′ 33″ S.
   Altitude. } .....True alt. 90° 9′ 17″ N. Lat. 23° 16′ 16″ S.

5. Parallel } .....Log 2·217686. Diff. Long. 165·1.
   Sailing. }

6. Mercator's } ...D. Lat. 265 S. M.D.L. 265. D. Long. 8129 W.
   Sailing. } ...Tan. 11·486791. Log dist. 3·910379.
   Course S 88° 8′ W. Distance 8135 miles.
   To seconds of arc, Course 88° 7′ 58″. Dist. 8133.

7. Tides.....Constant 0h 41m. 11h 26m A.M. 11h 44m P.M.

8. Amplitude.....A.T.G. 22d 17h 46m 0s. Red. dec. 23° 26′ 18″ S.
   Sin. 9·961601. True amp. E 113° 44′ S.
   Error 26° 33′ E. Deviation 5° 27′ W.
   To seconds of arc, Dev. 5° 28′ 24″ W.

9. Chronometer...Daily rate 2·5s Gaining.
   M.T.G. 23d 15h 11m 17s. P.D. 66° 34′ 38″.
   Eq. T. — 0m 4·06s. True alt. 44° 6′ 41″.
   Log 9·273697. H.A. 20h 34m 33s.
   M.T.S. 23d 20h 34m 29s. Long. 80° 48′ East.

10. Azimuth .....M.T.G. 19d 15h 37m 42s. P.D. 90° 1′ 6″.
    True alt. 25° 25′ 34″. Sin. 9·772658.
    True az. S 72° 40′ W. Error 6° 28′ W.
    Dev. 12° 38′ W. By Azimuth Tables 12° 38′ W.
    To seconds of arc, Dev. 12° 38′ 38″ West.

11. Reduction.....19d 11h 40m 30s. T. from Noon 27m 30s.
    Red. dec. 0° 4′ 51″ S. True alt. 51° 26′ 7″ S.
    Log 3·753578. Nat. num. 5670.
    M.Z.D. 38° 2′ N. Latitude 37° 57′ N.
    To seconds of arc, 37° 57′ 35″ N.

12. Star .....True alt. 68° 18′ 10″ S. Lat. 11° 18′ 18″ N.

EXAMPLES IN THE USE OF NAPIER'S DIAGRAM.

Example I.

7. In the following Table give the correct magnetic bearing of the distant object, and thence the deviation.

Ship's Head by Standard Compass.	Bearing of Distant Object by Standard Compass.	Deviation Required.	Ship's Head by Standard Compass.	Bearing of Distant Object by Standard Compass.	Deviation Required.
North	N 41° E	4° E	South	N 47° E	2° W
N.E.	N 54 E	9 W	S.W.	N 42 E	3 E
East	N 58 E	13 W	West	N 35 E	10 E
S.E.	N 51 E	6 W	N.W.	N 32 E	13 E

204 — 156 + 204 = 8)360

Correct Magnetic Bearing...N 45 E.

In this question the bearings are all in one quadrant of the Compass, they must therefore be added together and their sum divided by 8, the quotient is the correct magnetic bearing, and it is named N and E the same as all the bearings.

To Find the Deviations.

Correct.....N	45° E	N 45° E	N 45° E	N 45° E
Standard .....N	41 E	N 54 E	N 58 E	N 51 E
Deviations.....	4 E	9 W	13 W	6 W
Correct.....N	45° E	N 45° E	N 45° E	N 45° E
Standard .....N	47 E	N 42 E	N 35 E	N 32 E
Deviations	2 W	3 E	10 E	13 E

Place the Standard Compass Bearing with the ship's head North, namely N 41° E, under the correct magnetic bearing N 45° E; and as they are both of the same name, namely N and E, take their difference which will be the deviation when the ship's head is North.

Proceed in the same manner with the Standard Compass when the ship's head is N.E., and so on in regular order as arranged above, and thus the deviation with the ship's head on every point will be found.

To Name the Deviations.

Draw two lines at right angles to each other to represent the N, S, E and W, points of the Compass; from I, their point of intersection, draw a line I C in the N E quadrant to represent the correct magnetic bearing, and other two lines I s, I s, one on each side of I C to represent the Standard Compass bearings, place the point of a pencil on C, look from I along I C, then if the correct magnetic bearing be to the right hand of the Standard Compass bearing the deviation is East, but if it be to the left, the deviation is West; these rules may shortly expressed thus:

C right of *s*, deviation *E*.
C left of *s*, deviation W.

See page 228 Bergen's Navigation.

To Draw a Deviation Curve.

See pages 228 and 229 Bergen's Navigation. With a pair of dividers, take 4° the deviation with the ship's head North from the scale on the middle line and apply it to the North point at each end of the diagram, upwards when the deviation is East, from the middle line along the *dotted* line, or along the dotted line produced. Make a small pencil mark at the upper point of the dividers.

Next, take 9° the deviation opposite N E, from the scale, and apply it in the same manner along the dotted line, passing through N E on the middle line, downward when the deviation is W. Proceed in a similar manner with all the deviations.

The Rules for drawing the curve are concisely expressed thus:

Go along dotted, upward when East, downward when West. Draw a faint pencil line *fair* through all the dots, and when satisfied with it draw it in with ink.

To Shape the Course by the Standard Compass.

8. With the deviations as above, give the courses you would steer by the Standard Compass to make the following courses, correct magnetic.

Correct magnetic ...E N E;	E by S;	S W by S;	W N W
Standard .....N 81° E;	S 68°E;	S 32° W;	N 79° W

Remarks. Place one foot of a pair of dividers on the middle line at E N E, the first correct magnetic course, and the other foot at the point where the curve meets the plain line through E N E.

Then, keep the foot on the middle line line fixed, and bring the other foot to the middle line so that a line drawn through the point on the curve where the foot was and the point on the middle line where it is now, may be parallel to the dotted line, then the foot will touch the middle line at the point marked N 81° E, which is the course that must be steered by the Standard Compass.

When the courses do not pass along either plain or dotted lines; go from the middle line parallel to the plain lines and return to it parallel to the dotted lines, or shortly *go by plain, return by dotted.*

To Correct the Course Steered by the Standard Compass for Deviation.

9. Supposing you have steered the following Courses by the Standard Compass, find the correct Magnetic Courses made from the above Deviations.

Standard Courses...	N E ¼ E;	E by S;	W;	W by N;
Correct Magnetic...	N 44° E;	N 89°E;	N 80°W;	N 67°W;

Short Rule. Go by dotted, return by plain.

To Correct the Bearings of Two Distant Objects by the Standard Compass for the Deviation due to the Ship's Course.

10. You have taken the following bearings of two distant objects by your Standard Compass as above; with the ship's head at N N E, find the bearings correct magnetic.

First bearing South = S 0° E.	Second bearing W ¼ N = N 82° W.
Deviation 3 W	Deviation 3 W.
Correct Magnetic bearing S 3 E	Correct N 85 W.

Rule. Go by dotted; allow East Deviation to right, West to left.

Place one foot of the dividers on the middle line, and the other at the point where the curve crosses the dotted line. The distance measured between the points of the dividers, applied along the middle line from the North or South point shews the deviation to be 3°, and as the curve is below the middle line at the N N E point the deviation is W. Hence the first correct bearing is S 3° E, and the second is N 85° W.

Example II.

7. In the following Table give the Correct Magnetic Bearing of the distant object, and thence the deviation.

Ship's Head by Standard Compass.	Bearing of Distant Object by Standard Compass.	Deviation Required.	Ship's Head by Standard Compass.	Bearing of Distant Object by Standard Compass.	Deviation Required.
North	N 86° W	24° W	South	S 53° W	17° E
NE	W 22 S	2 E	SW	W 28 S	8 E
East	S 58 W	12 E	West	S 77 W	7 W
SE	S 55 W	15 E	NW	N 89 W	21 W

To Find the Correct Magnetic Bearings.

See page 283 Bergen's Navigation.

As the Compass bearings are here reckoned from different points, they must be reduced to equivalent bearings, so that all the bearings may be reckoned from the same point; and as there are more reckoned from the South point than from any other, it will be convenient to reckon them all from that point; as follows:

180°;	90°;	90°;	180°
N 86 W;	W 22 S;	W 28 S;	N 89 W
S 94 W	S 68 W	S 62 W	S 91 W

Next, arrange the bearings, both those given for the South point and the equivalents of the others, in regular order; beginning with the equivalent for the position of the ship's head North, and then with that of her head N E, and so on as follows.

S 94° W	S 53° W
S 68 W	S 62 W
S 58 W	S 77 W
S 55 W	S 91 W
275	283
	275
	8)558
	69¾ say = S 70° W Correct Magnetic Bearing.

To Find the Deviations, Correct and Standard.

Same name take difference.

Rules. *C* right of *s* Deviation *E.*
C left of *s* Deviation *W.*

Correct.....	S 70° W;	S 70° W;	S 70° W;	S 70° W;
Standard	S 94 W;	S 68 W;	S 58 W;	S 55 W;
Deviations ...	24 W;	2 E;	12 E;	15 E;

Correct.....	S 70° W;	S 70° W;	S 70° W;	S 70° W;
Standard	S 53 W;	S 62 W;	S 77 W;	S 91 W;
	17 E;	8 E;	7 W;	21 W;

To Shape a Course by the Standard Compass.

8. With the deviations as above, give the course you would steer by the Standard Compass to make the following courses correct magnetic.

Rule. *Go by plain, return by dotted.*

Magnetic.....	N N E	E N E	West	N W
Standard.....	N 31° E	N 60° E	N 80° W	N 21° W

To Correct the Course Steered by the Standard Compass for Deviation.

9. Supposing you have steered the following courses by the Standard Compass, find the correct magnetic courses made from the above deviation table.

Rule. *Go by dotted, return by plain.*

Standard.....	N N E	E N E	West	N W
Magnetic.....	N 7° E	N 77° E	S 83° W	N 66° W

Cross Bearings.

10. You have taken the following bearings of two distant objects by your Standard Compass as above; with the ship's head at NW by W, find the bearings, correct magnetic.

Rule. *Go by dotted.*

1st bearing S by W, say =	S 11° W.	2nd bearing E by S =	S 79° E
Deviation for ship's head ...	18 W		18 W
Correct magnetic bearing...	S 7 E		S 97 E
			180
			N 83 E

Example III.

7. In the following Table give the correct magnetic bearing of the distant object, and thence the deviation.

Ship's Head by Standard Compass.	Bearing of Distant Object by Standard Compass.	Deviation Required.	Ship's Head by Standard Compass.	Bearing of Distant Object by Standard Compass.	Deviation Required.
North	N 10° W	6° E	South	N 8° W	1° W
NE	N 15 W	11 E	SW	N 19 E	23 W
East	N 19 W	15 E	West	N 15 E	19 W
SE	N 20 W	16 E	NW	N 4 E	8 W

As some of the bearings in this question are in the NW quadrant, and others in the NE quadrant, add all the Westings together, and all the Eastings together, take the difference of the sums and divide it by 8, the quotient will be the correct magnetic bearing, as follows:

	N 10° W		N 19° E
	N 15 W		N 15 E
	N 19 W		N 4 E
	N 20 W		
	N 8 W	Sum of Eastings	N 38 E
		Sum of Westings	N 67 W
Sum	N 67 W		
			8)29

Correct magnetic bearing... $3\frac{5}{8}$, say = N 4° W.

To Find the Deviations.

Correct...	N 4° W	N 4° W	N 4° W	N 4° W
Standard	N 10 W	N 15 W	N 19 W	N 20 W
Deviations	6 E	11 E	15 E	16 E

Correct...	N 4° W	N 4° W	N 4° W	N 4° W
Standard	N 8 W	N 19 E	N 15 E	N 4 E
	1 W	23 W	19 W	8 W

Rules. *Correct and Standard*; *same name take difference, different name take sum.*

C right of *s* deviation *E*.
C left of *s* deviation *W*.

To Shape the Course by the Standard Compass.

8. With the deviations as above, give the courses you would steer by the Standard Compass to make the following courses correct magnetic.

Correct.....	N by E	E by N	S W by S	W N W
Standard	N 4° E	N 66° E	S 57° W	N 57° W

Rule. *Go by plain, return by dotted.*

To Correct the Course Steered by the Standard Compass for Deviation.

9. Supposing you have steered the following courses by the Standard Compass, find the correct magnetic courses made from the above deviations.

Standard.....	N E by N	E S E	W by S	N W by N
Correct	N 44° E	S 52° E	S 58° W	N 38° E

Rule. *Go by dotted, return by plain.*

Cross Bearings.

10. You have taken the following bearings of two distant objects by your Standard Compass as above, with the Ship's Head at W S W; find the bearings, Correct Magnetic.

Rule. *Go by dotted, allow E dev. to right, W dev. to left.*

1st bearing North, =	N 0° E
Dev.	23 W
Correct magnetic bearing,	N 23 W

2nd bearing East, =	N 90° E
Dev.	23 W
Correct	N 67 E

Example IV.

7. In the following Table, give the correct magnetic bearing of the distant object, and thence the deviation.

Ship's Head by Standard Compass.	Bearing of Distant Object by Standard Compass.	Required Deviation.	Ship's Head by Standard Compass.	Bearing of Distant Object by Standard Compass.	Required Deviation.
North	W 86° N	0°	South	W 88° N	2° W
NE	W 18 N	28 E	SW	N 40 W	14 W
East	W 12 N	24 E	West	N 30 W	24 W
SE	W 24 N	12 E	NW	N 32 W	22 W

As the most of the bearings in this question are taken from the West point towards the North, it will be convenient to reduce the remaining bearings to their equivalents, reckoned from the West point thus:

N 40° W	N 30° W	N 32° W
90	90	90
W 50 N	W 60 N	W 58 N

To Find the Correct Magnetic Bearing.

W 86° N	W 88° N
W 18 N	W 50 N
W 12 N	W 60 N
W 24 N	W 58 N
85	206
	85
	8)291
	$36\frac{3}{8}$ say = W 86° N.

To Find the Deviations.

Correct.....	W 86° N	W 86° N	W 86° N	W 86° N
Standard	W 86 N	W 18 N	W 12 N	W 24 N
Deviation.....	0	28 E	24 E	12 E

Correct.....	W 36° N	W 36° N	W 36° N	W 36° N
Standard	W 38 N	W 50 N	W 60 N	W 58 N
Deviation.....	2 W	14 W	24 W	22 W

Rules. *Correct and Standard same name take difference.*

C right of *s*, deviation *E*
C left of *s*, deviation *W*.

To Shape the Compass Course.

8. With the deviations as above, give the course you would steer by the Standard Compass to make the following Courses correct magnetic.

Correct.....	ENE	SE	W by S	NNW
Standard ...	N 45° E	S 63° E	N 76° W	N 14° W

Rule. *Go by plain, return by dotted.*

To Correct the Compass Course for Deviation.

9. Supposing you have steered the following courses by the Standard Compass, find the correct magnetic course made from the above deviations.

Standard NNE	E ½ N	SW	WNW
Correct N 38°E	S 71°E	S 31°W	S 87°W

Rule.—Go by dotted, return by plain.

To Correct the Compass Bearings.

10. You have taken the following bearings of two distant objects by your Standard Compass, as above, with the Ship's head at ESE, find the bearings correct magnetic.

Rules. *Go by dotted.* *Allow E deviation to right, W deviation to left.*

1st bearing SE	= S 45°E	2nd bearing SW by W	= S 56°W
Dev.	19E	Dev.	19E
Answer	S 26 E	Answer	S 75 W

EXERCISES.

Exercise I.

7.

Ship's head.	Compass Bearing.	Deviation.	Ship's Head.	Compass Bearing.	Deviation.
N	N 6°W		S	N 52°E	
NE	N 1 E		SW	N 51 E	
E	N 18 E		W	N 25 E	
SE	N 37 E		NW	N 1 W	

8. N by E SE by E S ½ E S by W

9. SE S by W WSW N by W

10. Ship's head SSW. 1st bearing W by N, 2nd bearing E by S.

Note. In this Exercise, one of the given courses in 8 is N by E, and one in 9 is N by W, and the deviations are large at those points, so that the required corresponding courses are beyond the limits of the diagram; in this case bring the ends of the diagram together so that all the lines may correspond, then complete the curve, and find the required courses.

Thus, for the course N by E in 8, produce the plain line at North near the word diagram, extend the curve at that end by taking the deviation along the plain line at the other end, and applying it to the plain line produced at the first mentioned end; then from N by E go by plain return by dotted; find the distance from the North point to where the other leg of the dividers meets the middle line produced, apply it to the scale, and the required course is found to be N 16° W.

The required course at N by W in 9 is found in a similar manner.

Exercise II.

7.

Ship's Head.	Compass Bearing.	Deviation.	Ship's Head.	Compass Bearing.	Deviation.
N	N 8°E		S	N 31°E	
NE	N 8 W		SW	N 35 E	
E	N 1 E		W	N 33 E	
SE	N 19 E		NW	N 22 E	

8. N ½ E W by S WSW N ½ W

9. NNE E by N SW W by N

10. Ship's head E by N. 1st bearing E; 2nd bearing S.

Exercise III.

7.

Ship's Head.	Compass Bearing.	Deviation.	Ship's Head.	Compass Bearing.	Deviation.
N	W 36°N		S	W 38°N	
NE	W 18 N		SW	N 40 W	
E	W 12 N		W	N 30 W	
SE	W 24 N		NW	N 32 W	

8. NNE ENE SE W by S

9. E by S South WSW NW by W

10. Ship's head ESE. 1st bearing SE; 2nd bearing SW by W.

Exercise IV.

7.

Ship's Head.	Compass Bearing.	Deviation.	Ship's Head	Compass Bearing.	Deviation.
N	N 12°W		S	N 14°W	
NE	N 19 W		SW	N 8 W	
E	N 24 W		W	N 1 W	
SE	N 19 W		NW	N 5 W	

8. N E by N E S E S W by W NW

9. E by N S ½ E W by S NNW

10. Ship's head E by N. 1st bearing E; 2nd bearing S.

Exercise V.

7.

Ship's Head.	Compass Bearing.	Deviation.	Ship's Head.	Compass Bearing.	Deviation.
N	N 7°W		S	N 5°W	
NE	N 2 W		SW	N 21 W	
E	N 5 E		W	N 18 W	
SE	N 2 E		NW	N 10 W	

8. N by E SE S W by W NNW

9. NE by N E ½ N S ½ W W

10. Ship's head W by S. 1st bearing NNE; 2nd bearing ESE.

Exercise VI.

7.

Ship's Head.	Compass Bearing.	Deviation.	Ship's Head.	Compass Bearing.	Deviation.
N	N 20°W		S	N 33°W	
NE	N 15 W		SW	N 46 W	
E	N 9 W		W	N 40 W	
SE	N 14 W		NW	N 26 W	

8. N ½ E SE ½ S S by W ½ W W ½ N

9. N by E ½ E E ½ S S by W ½ W N ½ W

10. Ship's head E by S. 1st bearing W; 2nd bearing N.

Exercise VII.

7.

Ship's Head.	Compass Bearing.	Deviation.	Ship's Head.	Compass Bearing.	Deviation.
N	N 7°W		S	N 2°W	
NE	N 12 W		SW	N 17 E	
E	N 17 W		W	N 14 E	
SE	N 18 W		NW	N 1 E	

8. NNE ESE S ½ E W by S

9. NNE ESE S ½ E W by S

10. Ship's head SE by E. 1st bearing E; 2nd bearing S

Exercise VIII.

7.

Ship's Head.	Compass Bearing.	Deviation.	Ship's Head.	Compass Bearing.	Deviation.
N	S 64°E		S	E 16°N	
NE	E 7 S		SW	E 4 S	
E	E 12 N		W	N112 E	
SE	N 67 E		NW	S 58 E	

8. NNE ½ E E by S SW ½ W NW

9. NNE E by N WSW NW

10. Ship's head ESE. 1st bearing E by N; 2nd bearing S by E.

Exercise IX.

7.

Ship's Head.	Compass Bearing.	Deviation.	Ship's Head.	Compass Bearing.	Deviation.
N	N 52°E		S	E 5°S	
NE	E 34 N		SW	E 1 N	
E	E 17 N		W	S 105 E	
SE	S 87 E		NW	E 88 N	

8. NE by N E ¼ N SSE NW by N

9. N ½ E SE by S SSW W ½ N

10. Ship's head S by E ½ E. 1st bearing ENE; 2nd bearing S by E.

Exercise X.

7.

Ship's Head.	Compass Bearing.	Deviation.	Ship's Head.	Compass Bearing.	Deviation.
N	E 29°S		S	E 21°S	
NE	S 45 E		SW	E 1 N	
E	S 87 E		W	N 86 E	
SE	E 49 E		NW	E 7 S	

8. NE ½ E ENE WSW W by N

9. N ½ E S ½ E SW W by S

10. Ship's head S W by S. 1st bearing N by W; 2nd bearing W by S.

Exercise XI.

7.

Ship's Head.	Compass Bearing.	Deviation.	Ship's Head.	Compass Bearing.	Deviation.
N	E 3°S		S	E 25°N	
NE	E 27 N		SW	S 88 E	
E	E 46 N		W	S 67 E	
SE	N 48 E		NW	E 24 S	

8. NE by E E by S W by S NW

9. NNE S SW NNW

10. Ship's head WSW. 1st bearing S by W; 2nd bearing W by S.

Exercise XII.

7.

Ship's Head.	Compass Bearing.	Deviation.	Ship's Head.	Compass Bearing.	Deviation.
N	S 45°W		S	S 51°W	
NE	S 25 W		SW	S 60 W	
E	S 27 W		W	S 68 W	
SE	S 40 W		NW	S 66 W	

8. N ½ E E ½ S S by E ½ E SW ½ W

9. E by S ½ S SW ½ S NW ¾ W NW ½ W

10. Ship's head E by S. 1st bearing SE. 2nd bearing SW.

ANSWERS TO EXERCISES IN THE CURVES.

Exercise I.

7. Correct magnetic bearing N 22°E. Deviations 28°E, 21°E, 4°E, 15°W, 30°W, 29°W, 8°W, 23°E.

8. Courses to steer by compass, N 16°W, S 39°E, S 26°W, S 41°W.

9. Correct magnetic courses, S 60°E, S 20°E, S 49°W, N 17°E.

10. Correct magnetic bearings S 69°W, N 69°E. Deviation for ship's head 32°W.

Exercise II.

7. Correct magnetic bearing N 17°E. Deviations 14°E, 25°E, 16°E, 2°W, 14°W, 18°W, 16°W, 5°W.

8. Courses to steer by compass, N 6°W, N 86°W, S 85°W, N 14°W.

9. Correct magnetic courses, N 44°E, S 82°E, S 27°W, S 87°W.

10. Deviation for ship's head 20°E. Correct magnetic bearings S 70°E, S 20°W.

Exercise III.

7. Correct magnetic bearing, W 36°N. Deviation 0°, 23°E, 24°E, 12°E, 2°W, 14°W, 24°W, 22°W.

8. Courses to steer by compass, N 13°E, N 45°E, S 62°E, N 76°W.

9. Correct magnetic courses, S 57°E, S 2°E, S 48°W, N 52°W.

10. Deviation for ship's head 19°E. Correct magnetic bearings S 26°E, S 75°W.

EXERCISE IV.

7. Correct magnetic bearing N 18°W. Deviations 1°W, 6°E, 11°E, 6°E, 1°E, 5°W, 12°W, 8°W.

8. Courses to steer by compass, N 30°E, S 77°E, S 65°W, N 38°W.

9. Correct magnetic courses, N 89°E, S 4°E, S 68°W, N 27°W.

10. Deviation for ship's head 10°E. Correct magnetic bearings, S 80°E, S 10°W.

EXERCISE V.

7. Correct magnetic bearing N 7°W. Deviations 0°, 5°N, 12°W, 9°W, 2°W, 14°E, 11°E, 3°E.

8. Courses to steer by compass, N 18°E, S 37°E, S 43°W, N 28°W.

9. Correct magnetic courses N 30°E, N 73°E, S 6°W, N 80°W.

10. Deviation for ship's head, 13°E. Correct magnetic bearings N 36°E, S 55°E.

EXERCISE VI.

7. Correct magnetic bearing N 25°W. Deviations 5°W, 10°W, 16°W, 11°W, 8°E, 21°E, 15°E, 1°E.

8. Courses to steer by compass N 12°E, S 35°E, S 5°W, S 78°W.

9. Correct magnetic courses, N 11°E, N 80°E, S 28°W, N 10°W.

10. Deviation for ship's head, 16°W. Correct magnetic bearings, S 74°W, N 16°W.

EXERCISE VII.

7. Correct magnetic bearing N 3°W. Deviations 4°E, 9°E, 14°E, 15°E, 1°W, 20°W, 17°W, 4°W.

8. Courses to steer by compass, N 17°E, S 82°E, S 3°E, N 86°W.

9. Correct magnetic courses, N 29°E, S 52°E, S 3°E, S 60°W.

10. Deviation for ship's head, 16°E. Correct magnetic bearings S 74°E, S 16°W.

Exercise VIII.

7. Correct magnetic bearing, S 85°E. Deviations 21°W, 2°W, 17°E, 28°E, 21°E, 1°E, 17°W, 27°W.

8. Courses to steer by compass, N 35°E, N 86°E, S 48°W, N 20°W.

9. Correct magnetic courses, N 9°E, S 89°E, S 59°W, N 72°W.

10. Deviation for ship's head, 25°E. Correct magnetic bearings S 76°E, S 14°W.

Exercise IX.

7. Correct magnetic bearing, N 74°E. Deviations 22°E, 18°E, 1°E, 19°W, 21°W, 15°W, 1°W, 17°E.

8. Courses to steer by compass, N 11°E, N 84°E, S 1°E, N 49°W.

9. Correct magnetic courses, N 28°E, S 55°E, S 4°W, N 83°W.

10. Deviation for ship's head, 22°W. Correct magnetic bearings, N 46°E, S 33°E.

Exercise X.

7. Correct magnetic bearing E 25°S. Deviations 4°W, 20°W, 28°W, 24°W, 4°E, 26°E, 29°E, 18°E.

8. Courses to steer by compass, N 77°E, S 85°E, S 43°W, S 72°W.

9. Correct magnetic courses, N 1°W, S 6°E, S 71°W, N 72°W.

10. Deviation for ship's head, 22°E. Correct magnetic bearings, N 11°E, N 79°W.

Exercise XI.

7. Correct magnetic bearing E 11°N. Deviations 14°W, 16°E, 35°E, 31°E, 14°E, 18°W, 34°W, 35°W.

8. Courses to steer by compass, N 42°E, N 72°E, N 65°W, N 20°W.

9. Correct magnetic courses, N 24°E, S 14°W, S 33°W, N 50°W.

10. Deviation for ship's head 25°W. Correct magnetic bearings, S 14°E, S 54°W.

Exercise XII.

7. Correct magnetic bearing S 48°W. Deviations 3°E, 23°E, 21°E, 8°E, 3°W, 12°W, 20°W, 18°W.

8. Courses to steer by compass, N 1°E, N 72°E, S 19°E, S 64°E.

9. Correct magnetic courses, S 58°E, S 36°W, N 73°W, N 66°W.

10. Deviation for ship's head, 18°E. Correct magnetic bearings S 27°E, S 63°E.

SUMNER'S METHOD.

In the following Examination Paper, the M.T.G. is given, and the declination and equation of time are corrected for the time from the nearest noon. Then with the first assumed latitude 49° 50'N the longitude is found exactly as in finding the longitude by chronometer.

The process is repeated with the same altitude and polar distance, and the second assumed latitude 50° 20'N.

Note. See Arts. 98, 99, 100, and 222, Bergen's Navigation.

Exn. 6. a. *Port of*_____

Rotation No.

EXAMINATION PAPER.

TO BE USED BY A CANDIDATE FOR A CERTIFICATE OF COMPETENCY AS A

Issued by the Board of Trade, in pursuance of 17 and 18 Vic., c. 104.

FIRST MATE.

*To be used at the above Port this*_____*day of*_____

N.B. A Candidate for a First Mate's Certificate of Competency will be required to work the questions in Papers Exn. 4, Exn. 5, and Exn. 6, in addition to the questions in this Paper.

If at sea on November 23rd, 1876, A.M., and uncertain of my position, when a chronometer shewed 22d 20h 21m 15s G.M.T. Suppose the observed altitude of the Sun's L.L. be 5° 42′ 30″, and again P.M. the same day, when the chronometer shewed 23d 1h 50m 27s G.M.T., the observed altitude of the sun's L.L. be 14° 25′ 54″. The ship have made 26 miles on a true West course in the interval. Height of the eye 17 feet. Required the line of bearing when the first altitude was taken, and the position of the Ship by " Sumner's Method " when the second altitude was observed, assuming the latitudes 49° 50'N and 50° 20'N.

Space for Minor Corrections

M.T.G. 1876.

	d	h	m	s
November	22	20	21	15
	23	0	0	0
		3	38	45
				3·6

Cosec.

20 27 0	0·028271
	+ 47
110 27 59	0·028318

Diff. 79
59
711
395
46,61

Cos.

83 1 0	9·084864
	— 1015
83 1 59	9·083849

Diff. 1721
59
15489
8605
1015,39

Cos.

83 16 0	9·069107
	— 1054
83 16 59	9·068053

Diff. 1786
59
16074
8930
1053,74

CALCULATION.

FIRST LINE OF BEARING.

Var.	*Dec.*	*Eq. T.*	*Var.*
		m s	
30″·69	20° 29′ 49″ S	— 13 16·21	·724
3·6	— 1 50	+ 2·61	3·6
18414	20 27 59	— 13 18·82	4344
9207	90 0 0		2172
60)11,0·484	P.D. 110 27 59		2·6064
1 50·4			

ASSUMED LATITUDE 49° 50′ N.

Obs. alt.	5° 42′ 30″	Alt... 5° 45′ 59″	
Dip....	— 4 4	Lat.. 49 50 0	Sec... 0·190431
	5 38 26	P.D.. 110 27 59	Cosec. 0·028318
Corr...	— 8 42	2)166 3 58	
	5 29 44	83 1 59	Cos... 9·083849
Sem...	+ 16 15	77 16 0	Sin... 9·989186
True alt.	5 45 59	h m s	Log... 9·291784
		H.A... 20 29 54	92
		Eq. T. — 13 19	
		d	14=2
		M.T.S. Nov... 22 20 16 35	
		M.T.G. Nov... 22 20 21 15	
		0 4 40	
		60 0	
		4)4 40	

Longitude 1° 10′ West.

ASSUMED LATITUDE 50° 20′N.

Alt...	5° 45′ 59″	
Lat..	50 20 0	Sec... 0·194961
P.D.	110 27 59	Cosec. 0·028318
	2)166 33 58	
	83 16 59	Cos. .. 9·068053
	77 31 0	Sin... 9·989609
	h m s	Log .. 9·280941
H.A.	20 32 42	109
Eq. T.	— 13 19	s.
	d	15=2
	22 20 19 23	M.T.S. Nov.
	22 20 21 15	M.T.G. Nov.
	0 1 52	
	60 60	
	4)1 112	

Longitude 0° 28′ West.

PROJECTION OF THE CHART.

Draw the assumed parallels of latitude, and mark both positions as found by the preceding calculation, on the chart; call the position on the lower latitude A and that on the higher latitude B. Draw a straight line through A and B; this line will be the *first line of bearing*. Find its direction by the compass, and express it in degrees. It is true N42°E.

Next, take any point P in the line A B, set off the true course West, and the distance, 26 miles, run in the interval to a point C.

Through C draw a line parallel to A B, and mark it A′ B′, which are read A dash and B dash respectively.

Now, suppose the ship's computed positions, at the time of taking the second altitude, to be as follows: where D and E denote the respective positions on the chart.

D	E
Latitude 49° 50′ N	Latitude 50° 20′ N
Longitude 0 18¼W	Longitude 1 37¾ W

Find the ship's position on the chart at the time of taking the second altitude. Proceed as follows:—Mark the given positions D and E on the chart. Draw a line from D to E; this line will be the *second line of bearing*. Mark the point where it intersects the line A′ B′ by the letter S; then S is the ship's position at the time of taking the second altitude, and by the chart it is in latitude 50° 13′ N, Longitude 1° 18′ W.

To find the Sun's Bearing.

The first altitude was taken in the forenoon and when the ship was North of the sun. In this case, look from A to B, and allow 90° to the right hand of the first line of bearing, thus :—

First line N 42°E true
Allow to right 90

N 132 E
180

Sun's bearing S 48 E true

Notes 1. In Sumner's Method the longitudes given by the Examiners are found with the given assumed latitudes; the second altitude and the declination and equation of time due to the second, Greenwich date.

2. The first line of bearing being produced meets the land about 8 miles to the West of Beachy Head. See Arts. 99 and 100, pages 143 and 144, Bergen's Navigation, for some remarks on the utility of this problem, and a modification of it.

EXERCISES.

1. If at Sea on March 15th, 1865, A.M., and uncertain of my position, when a Chronometer shewed 14d. 20h. 10m. 51s. G.M.T. Suppose the observed altitude of the Sun's L.L. be 14° 14′ 0″, and again P.M. the same day, when the Chronometer shewed 15d. 3h. 45m. 9s. G.M·T. the observed altitude of the Sun's L.L. be 23° 17′ 0′ The ship have made 21 miles on a true course N by E ¼ E in the interval. Height of the eye 16 feet. Required the line of bearing when the first altitude was taken, and the position of the Ship by " Sumner's Method " when the second altitude was observed ; assuming the latitudes 49° 0′ N and 49° 40 N.

Again ; suppose the Ship's calculated position at the time of taking the second altitude to be as follows :—

D.	E.
Latitude 49° 0′ N	Latitude 49° 40′ N
Longitude 4 17 W	Longitude 4 58½ W

Find the Ship's position on the chart at the time of taking the second altitude ?

2. If at sea on April 5th, 1866, P.M. and uncertain of my position, when a Chronometer shewed 6d. 1h. 17m. 25s. G.M.T. Suppose the observed altitude of the Sun's L.L. be 45° 7′ 10″, and again P.M. the same day, when the Chronometer shewed 6d. 4h. 23m. 24s. G.M.T. the observed altitude of the Sun's L.L. be 24° 52′ 10″. The ship have made 46 miles on a true N.E. course in the interval. Height of the eye 18 feet. Required the the line of bearing when the first altitude was taken, and the position of the ship by " Sumner's Method " when the second altitude was observed ; assuming the latitudes 50° 10′ N and 50° 30′ N.

Again ; suppose the Ship's calculated position at the time of taking the second altitude to be as follows:—

D.	E.
Latitude 50° 30′ N	Latitude 51° 0′ N
Longitude 7 17 W	Longitude 7 36 W

Find the Ship's position on the chart at the time of taking the second altitude ?

NOTE.—In this question, the given course and distance sailed, takes the Ship to the Northward of the higher assumed lalitude, it is therefore taken as the lower assumed latitude for the second line of bearing.

3. If at sea on January 12th, 1876, A.M., and uncertain of my position, when a Chronometer shewed 11d. 21h. 29m. 51s. G.M.T. Suppose the observed altitude of the Sun's L.L. be 6° 18′ 30″, and again P.M., the same day when the Chronometer shewed 12d. 3h. 55m. 30s. G.M.T. the observed altitude of the L.L. be 5° 39′ 0″. The Ship have made 32 miles on a true S.E. by E. ¼ E. course in the interval. Height of the eye 21 feet. Required the line of bearing when the first altitude was taken, and the position of the

Ship by "Sumner's Method" when the second altitude was observed; assuming the latitudes 50° 0′ N and 51° 0′ N.

Again; suppose the Ship's position at the time of taking the second altitude to be as follows:—

D.	E.
Latitude 50° 0′ N	Latitude 51° 0′ N
Longitude 6 33 W	Longitude 8 6¾ W

Find the Ship's position on the chart at the time of taking the second altitude?

4. If at sea on February 24th, 1876, A.M., and uncertain of my position, when a Chronometer shewed 23d 21h 14m 46s G.M.T. Suppose that the observed altitude of the Sun's L.L. be 15° 15′ 20″, and again P.M. the same day when the Chronometer shewed 24d 2h 37m 17s. G.M.T., the observed altitude of the Sun's L.L. be 24° 43′ 0″. The ship have made 31 miles on a true NE ½ E course in the interval. Height of the eye 23 feet. Required the line of bearing when the first altitude was taken, and the position of the Ship by "Sumner's Method" when the second altitude was observed; assuming the latitudes 50° 0′N and 50° 30′N.

Again; suppose the Ship's position at the time of taken the second altitude to be as follows:—

D.	E.
Latitude 50° 0′ N	Latitude 50° 30′ N
Longitude 5 43 W	Longitude 6 56¾W

Find the Ship's position on the chart at the time of taken the second altitude?

5. If at sea on March 9th, 1876, A.M., and uncertain of my position, when a Chronometer shewed 8d 21h 35m 2s G.M.T. Suppose the observed altitude of the Sun's L.L. be 22° 27′ 30″, and again P.M. the same day when the Chronometer shewed 9d 1h 43m 29s G.M.T., the observed altitude of the Sun's L.L. be 32° 34′. The Ship have made 18 miles on a true WNW course in the interval. Height of the eye 19 feet. Required the line of bearing when the first altitude was taken, and the position of the Ship by "Sumner's Method" when the second altitude was observed; assuming the latitudes 51° 0′N and 51° 30′N.

Again; supose the Ship's position at the time of taken the second altitude to be as follows:—

D.	E.
Latitude 51° 0′ N	Latitude 51° 30′
Longitude 5 32 W	Longitude 7 45 ¼ W

Find the Ship's position on the chart at the time of taking the second altitude?

6. If at sea on April, 1876, P.M. and uncertain of my position, when a Chronometer shewed 10d 1h 17m 46s. G.M.T. Supposed the observed altitude of the Sun's L.L. be 45° 17′ 15″, and again P.M. the same day when the Chronometer shewed 10d 5h 9m 14s G.M.T., the observed altitude of

Sun's L.L. be 18° 17′. The Ship have made 12 miles on a true W ¼ N course in the interval. Height of the eye 27 feet. Required the line of bearing when the first altitude was taken, and the position of the ship by "Sumner's Method" when the second altitude was observed; assuming the latitude 51° 10′ N and 51° 30′ N.

Again; suppose the Ship's positions at the time of taking the second altitude to be as follows:—

D.	E.
Latitude 51° 10′ N	Latitude 51° 30′ N
Longitude 6 18 W	Longitude 6 18¾ W

Find the Ship's position on the chart at the time of taking the second altitude?

7. If at sea, on May, 1876, A.M., and uncertain of my position, when a Chronometer showed 29d 19h 21m 19s G.M.T. Suppose the observed altitude of the Sun's L.L. be 23° 42′ 10″, and again P.M. the same day when the Chronometer shewed 30d 2h 7m 9s G.M.T., the observed altitude of the Sun's L.L. be 56° 45′. The ship have made 67 miles on a true W. course in the interval. Height of the eye 15 feet. Required the line of bearing when the first altitude was taken, and the position of the Ship by "Sumner's Method" when the second altitude was observed; assuming the latitudes 50° 0′ N and 51° 0′ N.

Again; suppose the Ship's positions at the time of taking the second altitude to be as follows:

D.	E.
Latitude 50° 0′ N	Latitude 51° 0′ N
Longitude 10 20 W	Longitude 12 21¾ W

Find the Ship's position on the chart at the time of taking the second altitude?

8. If at sea, on June 24th, 1876, A.M., and uncertain of my position, when a Chronometer showed 24d 0h 5m 54s G.M.T. Suppose the observed altitude of the Sun's L.L. 60° 26′ 15″, and again P.M. the same day when the Chronometer shewed 24d 7h 19m 36s G.M.T. observed altitude of the Sun's L.L. be 12° 57′. The Ship have made 33 miles on a true E ¼ S course in the interval. Height of the eye 20 feet. Required the line of bearing when the first altitude was taken, and the position of the Ship by "Sumner's Method" when the second altitude was observed; assuming the latitudes 51° 30′ N and 51° 38′ N.

Again; suppose the Ship's positions at the time of taking the second altitude to be as follows:

D.	E.
Latitude 51° 30′ N	Latitude 51° 38′ N
Longitude 10 50¼ W	Longitude 10 45 W

Find the Ship's position on the chart at the time of taking the second altitude?

9. If at sea on July, 1876, P.M. at Ship, and uncertain of my position, when a Chronometer showed 5d 1h 3m 59s G.M.T. Suppose the observed altitude of the Sun's L.L. be 61° 16′ 10″, and again P.M. the same day when the Chronometer showed 5d 6h 17m 9s G.M.T., the observed altitude of the Sun's L.L. be 20° 20′. The Ship have made 18 miles on a true W by N ¼ N course in the interval. Height of the eye 24 feet. Required the line of bearing when the first altitude was taken, and the position of the Ship by "Sumner's Method" when the second altitude was observed; assuming the latitudes 50° 40′ N and 50° 52′ N.

Again; suppose the Ship's positions at the time of taking the second altitude be as follows:

D.		E.	
Latitude	50° 40′ N	Latitude	50° 52′ N
Longitude	8 12 W	Longitude	8 8 W

Find the Ship's position on the chart at the time of taking the second altitude?

10. If at Sea on August, 1876, A.M. at Ship, and uncertain of my position, when the Chronometer shewed 16d. 8h. 0m. 20s. Suppose the observed altitude of the Sun's L.L. be 28° 14′ 10″, and again P.M. at Ship the same day when the Chronometer shewed 16d. 14h. 0m. 20s. G.M.T. the observed altitude of the Sun's L.L. be 46° 21′. The ship have made 30 miles on a true E. course in the interval. Height of the eye 12 feet. Required the line of bearing when the first altitude was taken, and the position of the Ship by "Sumner's Method" when the second altitude was observed; assuming the latitudes 50° 10′ N. and 50° 50′ N.

Again; suppose the Ship's positions at the time of taking the second altitude to be as follows:—

D.		E.	
Latitude	50° 10′ N	Latitude	50° 50′ N
Longitude	179 16½E	Longitude	178 5 E

Find the Ship's position on the chart at the time of taking the second altitude?

11. If at Sea on September 14th, 1876, A.M., and uncertain of my position when a Chronometer shewed 13d 19h 4m 57s G.M.T. Suppose the observed altitude of the Sun's L.L. be 10° 25′ 10″, and again P.M. the same day when the Chronometer showed 14d 3h 6m 50s G.M.T., the observed altitude of the Sun's L.L. be 30° 24′. The ship have made 32 miles on a true NE by E ½ E course in the interval. Height of the eye 17 feet. Required the line of bearing when the first altitude was taken, and the position of the ship by "Sumner's Method" when the second altitude was observed; assuming the latitudes 49° 30′ N and 50° 0′ N.

Again; suppose the Ship's computed positions at the time of taking the second altitude be as follows:

D.	E.
Latitude 49° 30′ N	Latitude 50° 0′ N
Longitude 3 58 W	Longitude 4 32½ W

Find the Ship's position on the chart at the time of taking the second altitude ?

12. If at sea on October 20th, 1876, P.M., and uncertain of my position, when a Chronometer showed 20d 0h 30m 54s G.M.T. Suppose the observed altitude of the Sun's L.L. be 29° 37′ 15″, and again P.M. the same day when the Chronometer showed 20d 3h 44m 50s G.M.T., the observed altitude of the Sun's L.L. be 12° 21′. The Ship have made 24 miles on a true NNE ½ E course in the interval. Height of the eye 20 feet. Required the line of bearing when the first altitude was taken, and the position of the Ship by Sumner's Method " when the second altitude was observed; assuming the latitudes 49° 20′ N and 49° 28′ N.

Again; suppose the Ship's calculated positions at the time of taking the second altitude to be as follows:

D.	E.
Latitude 49° 20° N	Latitude 49° 50′ N
Longitude 3 47 W	Longitude 4 17½W

Find the Ship's position on the chart at the time of taking the second altitude ?

13. If at sea on November 23rd, 1876, A.M., and uncertain of my position, when a Chronometer showed 22d 20h 17m 28s G.M.T. Suppose the observed altitude of the Sun's U.L. be 6° 14′ 40″, and again P.M. the same day, when the Chronometer showed 23d 1h 46m 40s G.M.T., the observed altitude of the Sun's U.L. be 14° 58′ 20″. The Ship have made 5 miles on a true West course in the interval. Height of the eye 17 feet. Required the line of bearing when the first altitude was taken, and the position of the ship by " Sumner's Method " when the second altitude was observed; assuming the latitudes 49° 50′ N and 50° 20′ N.

Again: suppose the Ship's calculated positions at the time of taking the second altitude to be as follows:

D.	E.
Latitude 49° 50′ N	Latitude 50° 20′ N
Longitude 0 43½ E	Longitude 0 41 W

Find the Ship's position on the chart at the time of taking the second altitude ?

14. If at sea on December 5th, 1876, A.M., and uncertain of my position, when a Chronometer shewed 4d 21h 10m 2s G.M.T. Suppose the observed altitude of the Sun's U.L. be 9° 27′ 7″, and again P.M. the same day, when the Chronometer shewed 5d 2h 5m 59s G.M.T., the observed altitude of the Sun's U.L. be 9° 39′ 0″. The Ship have made 21 miles on a true WNW course in the interval. Height of the eye 19 feet. Required the line of bearing when the first altitude was taken, and the position of the ship by Sumner's Method " when the second altitude was observed; assuming the latitudes 51° 30′ N and 52° 0′ N.

Again; suppose the Ship's positions at the time of taking the second altitude be as follows:

D.	E.
Latitude 51° 30′ N	Latitude 52° 0′ N
Longitude 3 16¼ E	Longitude 2 3¼ E

Find the Ship's position on the chart at the time of taking the second altitude?

15. If at sea on January 14th, 1876, A.M., at Ship, and uncertain of my position, when a Chronometer showed, January 14th, 11h 29m 0s G.M.T. Suppose the observed altitude of the Sun's L.L. be 18° 53′ 44″, and again the same day when the Chronometer showed January 14th, 13h 12m 0s G.M.T., the observed altitude of the Sun's L.L. be 18° 6′ 51″. The Ship have made 3 miles on a true North course in the interval. Height of the eye 19 feet. Required the line of bearing when the first altitude was taken, and the position of the Ship by "Sumner's Method" when the second altitude was observed; assuming the latitudes 48° 43′ N and 49° 30′ N.

Again; suppose the Ship's positions at the time of taking the second altitude as follows:

D	E.
Latitude 48° 43′ N	Latitude 49° 30′ N
Longitude 178 5 W	Longitude 177 28¼ E

Find the Ship's position on the chart at the time of taking the second altitude?

ANSWERS TO SUMNER'S METHOD.

No.	Pol. Dist.	Eq. T.	True Alt.	W. Longitudes at		First Line of Bearing.		Degrees Sun's True Bearing.	Ship's position on Chart.	
				Lower Latitude.	Higher Latitude.	In Points.	In Degrees.		Lat. N	Long. W
1	92° 4′ 19″	m. s. + 9 5	14° 22′ 33″	5° 35½′	5° 12′	N by E ⅜ E +	N 20° E	S 70° E	49° 49′	5° 7½′
2	83 30 18	+ 2 27	45 18 8	7 22½	9 21¾	W by N ½ N	N 56 W	S 34 W	50 53	7 31
3	111 43 38	+ 8 23	6 22 18	9 0¾	7 22½	NE +	N 45 E	S 45 E	50 25	7 11
4	99 37 47	+ 13 31	15 23 28	6 55½	6 20	NE ¾ N	N 37 E	S 53 E	50 15¾	6 22
5	94 16 45	+ 10 37	22 37 10	6 15½	5 34½	NE ½ N	N 39 E	S 51 E	51 13¾	6 33½
6	81 47 47	+ 1 11	45 27 15	4 53½	6 25½	W by N ¾ N	N 70 W	S 20 W	51 25	6 17½
7	68 9 25	— 2 42	23 52 6	9 26½	9 36	N ½ W	N 6 W	S 84 W	50 28¾	11 19
8	66 34 55	+ 2 12	60 37 8	12 8¼	11 34½	E by N ¾ N	N 70 E	S 20 E	51 31	10 49½
9	67 15 17	+ 4 21	61 26 39	7 14 E	8 32 E	W by N ½ N	N 76 W	S 14 W	50 48	8 9½
10	76 32 19	+ 3 54	28 24 56	179 22½ W	179 38 W	N by E	N 11 E	S 79 E	49 44	179 58
11	86 44 6	— 4 38	10 32 7	4 58	4 52	N ¾ E	N 8 E	S 82 E	49 44	4 14
12	100 34 55	— 15 14	29 47 25	4 46½	6 32½ E	W ⅜ N	N 83 W	S 7 W	49 40	4 7½
13	110 27 55	— 13 19	5 45 59	0 13½ E	0 28¾	NE ½ N	N 42 E	S 48 W	50 2	0 0 E
14	112 27 19	— 9 1	9 0 57	2 36½ E	3 47½ W	NE by E	N 34 E	S 56 E	51 48	2 30
15	111 17 17	+ 9 22	19 3 5	177 11 15	175 15 30	E ⅞ N	N 80 E	S 10 E	49 3¾	180 0

A TABLE OF THE ANGLES.

Which every point and eighth of a point makes with the meridian.

POINTS.	NO.	DEGREES, &c.	NO.	POINTS.
North.	0	0° 0′ 0″	0	South.
	1/8	1 24 22	1/8	
	1/4	2 48 45	1/4	
	3/8	4 13 7	3/8	
	1/2	5 37 30	1/2	
	5/8	7 1 52	5/8	
	3/4	8 26 15	3/4	
	7/8	9 50 37	7/8	
N by E....N by W....	1	11 15 0	1	S by W.....S by E
	1/8	12 39 22	1/8	
	1/4	14 3 45	1/4	
	3/8	15 28 7	3/8	
	1/2	16 52 30	1/2	
	5/8	18 16 52	5/8	
	3/4	19 41 15	3/4	
	7/8	21 5 37	7/8	
NNE.... NNW.....	2	22 30 0	2	SSW.....SSE
	1/8	23 54 22	1/8	
	1/4	25 18 45	1/4	
	3/8	26 43 7	3/8	
	1/2	28 7 30	1/2	
	5/8	29 31 52	5/8	
	3/4	30 56 15	3/4	
	7/8	32 20 37	7/8	
NE by N..NW by N ..	3	33 45 0	3	SW by S.....SE by S
	1/8	35 9 22	1/8	
	1/4	36 33 45	1/4	
	3/8	37 58 7	3/8	
	1/2	39 22 30	1/2	
	5/8	40 46 52	5/8	
	3/4	42 11 15	3/4	
	7/8	43 35 37	7/8	
NE..... NW.....	4	45 0 0	4	SW.....SE
	1/8	46 24 22	1/8	
	1/4	47 48 45	1/4	
	3/8	49 13 7	3/8	
	1/2	50 37 30	1/2	
	5/8	52 1 52	5/8	
	3/4	53 26 15	3/4	
	7/8	54 50 37	7/8	
NE by E..NW by W ..	5	56 15 0	5	SW by W....SE by E
	1/8	57 39 22	1/8	
	1/4	59 3 45	1/4	
	3/8	60 28 7	3/8	
	1/2	61 52 30	1/2	
	5/8	63 16 52	5/8	
	3/4	64 41 15	3/4	
	7/8	66 5 37	7/8	
ENE .....WNW	6	67 30 0	6	WSW..... ESE
	1/8	68 54 22	1/8	
	1/4	70 18 45	1/4	
	3/8	71 43 7	3/8	
	1/2	73 7 30	1/2	
	5/8	74 31 52	5/8	
	3/4	75 56 15	3/4	
	7/8	77 20 37	7/8	
E by N....W by N....	7	78 45 0	7	W by S.....E by S
	1/8	80 9 22	1/8	
	1/4	81 33 45	1/4	
	3/8	82 58 7	3/8	
	1/2	84 22 30	1/2	
	5/8	85 46 52	5/8	
	3/4	87 11 15	3/4	
	7/8	88 35 37	7/8	
East .....West..	8	90 0 0	8	West.....East

PRACTICAL EXAMINATION IN THE USE

OF THE

BLANK CHART

FOR ALL GRADES WHERE THE CHART IS USED.

DEVIATION CARD, No. 1.

SHIP'S HEAD WHEN BUILDING.

Ship's Head. Correct Magnetic.	Deviations.	Ship's Head by Compass.	Deviations.
North	2 East	North	2 East
N by E	6	N by E	10
NNE	10	NNE	16
NE by N	15	NE by N	22
NE	20	NE	24
NE by E	22	NE by E	25
ENE	24	ENE	24
E by N	25	E by N	22
East	25	East	20
E by S	23	E by S	16
ESE	19	ESE	15
SE by E	14	SE by E	9
SE	9	SE	6
SE by S	3	SE by S	2
SSE	3 West	SSE	2 West
S by E	4	S by E	3
South	6	South	5
S by W	7	S by W	6
SSW	9	SSW	7
SW by S	11	SW by S	9
SW	12	SW	10
SW by W	14	SW by W	12
WSW	17	WSW	14
W by S	19	W by S	15
West	20	West	18
W by N	21	W by N	20
WNW	20	WNW	21
NW by W	18	NW by W	21
NW	16	NW	20
NW by N	12	NW by N	17
NNW	8	NNW	12
N by W	4	N by W	6

Exn. 9 C.

Rotation No. 224

Port of Sunderland.

EXAMINATION IN CHART

FOR ALL GRADES WHERE THE CHART IS USED.

The Candidate will be required to work out the following questions on either a true or magnetic chart, whichever may be handed to him by the Examiner; and also determine whether the chart is a true or magnetic one, and whether it is for the northern or southern, and eastern or western Hemisphere.

EXAMPLE I.

(1.) Using deviation card No.....find the course to steer by compass from Boulogne Light to the Royal Sovereign Shoal Light, also the distance.

Answer.—Compass Course N 51° 37′=NW ⅝ W. Distance 44 miles. Variation 19° 25′W. Deviation 20° 22′W.

(2.) With the ship's head on the above-named compass course, a (Lighthouse) Dungeness, bore by compass North, and Boulogne bore S 52°E by the same compass, find the ship's position.

Answer.—Latitude 50° 44½′N. Longitude 1° 13′E.

(3.) With the ship's head as above, a (Lighthouse) Beachy Head bore by compass N 14°W, and after continuing on the same course 15 miles, it bore N 68°E, find the position of ship, and her distance from Beachy Head at the time of taking the second bearing.

Answer.—Latitude 50° 86′N. Longitude 0° 6′E. Distance 9½ miles.

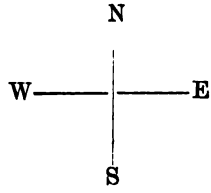
All the foregoing questions must be answered, but this does not preclude the examiner from putting any other questions of a practical character or which the local circumstances of the port may require.

(Signature) Wm. C. BERGEN,
Date 9th June, 1881,
Chart used English Channel.

EXAMINATION IN CHART.

Solution of the preceding Questions.

(1.) Lay the edge of a parallel ruler over Boulogne Light and the Royal Sovereign Shoal Light, then move the ruler parallel to the line through them until an edge pass through the centre of the true compass, the point of the compass coinciding with the edge of the ruler shews the true course from Boulogne to the Shoal to be W $\frac{1}{8}$ S, and by applying a pair of dividers to the space between them and then to the latitude scale at the side of the chart the distance is found to be 44 miles; then proceed as follows:



By the true Chart; to points, Degrees and Minutes.

True course from Boulogne to Shoal W $\frac{1}{8}$ S	= S	88°	36′ W
Variation; from chart		19	25 W allow to right hand
	S	108	1 W
		180	0
Magnetic course W by N $\frac{5}{8}$ N	= N	71	59 W
Deviation, from left side of card		20	22 W allow to right hand
Compass course NW $\frac{5}{8}$ W	= N	51	37 W

To find the Deviation for W by N $\frac{5}{8}$ N.

Ship's Head.	Deviation.	
W by N	21°	21° 0′
WNW	20	— 38
	1	20 22 Deviation due to W by N $\frac{5}{8}$ N.
	60	
	8)60	difference in minutes
	7·5	difference due to $\frac{1}{8}$ point
	5	
	37·5	difference due to $\frac{5}{8}$ point

Note. It is in general sufficiently near the truth to work to the nearest degree, as follows:

By the Magnetic Chart, to Points and Degrees.

Find the magnetic course with the parallel ruler and magnetic compass in the same manner as in finding the true course.

Magnetic course from Boulogne to Shoal W by N $\frac{5}{8}$ N = N 72°W
Deviation 20 W to right
Compass course NW $\frac{5}{8}$ W = N 52 W

Note. It sometimes happens that the course is between two courses on the middle line, and that there is a considerable difference in the deviations of the two adjoining courses.

Thus, suppose that for the course NE the deviation is 2°E, and for the course NE by E it is 10°W, and that it is required for the course NE $\frac{3}{4}$ E, then proceed to find the difference of deviations for every $\frac{1}{4}$ point, and thence the deviation for NE $\frac{3}{4}$ E as follows.

Ship's Head		Deviations.
NE	Add 8° dev. for each $\frac{1}{4}$ point.	2°E
NE $\frac{1}{4}$ E		1 W
NE $\frac{1}{2}$ E		4 W
NE $\frac{3}{4}$ E		7 W
NE by E		10 W

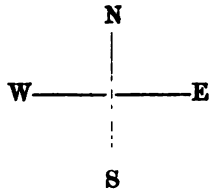
Difference of deviation 4)12 for 1 point
8 „ $\frac{1}{4}$ „

Thus the deviation for the ship's head NE $\frac{3}{4}$ E is 7°W, or by taking 3° from 10°W, the deviation for NE $\frac{3}{4}$ E is 7°W.

It often happens that the deviation due to an intermediate course can be seen at once by inspection.

Thus in question (4), in this example, the deviation is required for NW $\frac{1}{4}$ W and by the Table.

The deviation for ship's head NW = 16°W
„ „ NW by W = 18 W
And it is evident that for ship's head NW $\frac{1}{4}$ W = 17 W



(2.) *By True Chart, to Points, Degrees and Minutes.*

Compass bearings, Dungeness North	= N 0° 0′W	Boulogne SE ⅝ E	= S 52° 2′ E
Deviation same as in (1)	20 22W.	Allow to left	20 22 W
Magnetic bearings N by W ¾ W	= N20 22W	E by S ⅝ S	= S 72 24 E
Variation same as in (1)	19 25W	Allow to left	19 25W
True bearings NW ¼ N	= N 39 47W		S 91 49 E
			180 0
			E ¼ N 88 11 E

By Magnetic Chart, to Points and Degrees.

Compass bearings Dungeness North	= N 0°W	Boulogne SE ⅝ E	= S 52° E
Deviation same as in (1)	20 W	to left	20 W
Magnetic bearings N by W ¾ W	= N 20 W	E by S ⅝ S	= S 72 E

Draw a line through Dungeness bearing N by W ¾ W magnetic, or NW ¼ N true, and another through Boulogne bearing E by S ⅝ S magnetic, or E ¼ N true, the point where they meet is the position of the ship on the chart, and it is in Latitude 50° 44′N, Longitude 1° 13′E.

(3). *By True Chart, to Degrees and Points.*

Beachy Head bore by compass	N 14°W,	and afterwards	N 68°E
Deviation same as in (1)	20 W	to left	20 W
Magnetic bearings NW by N	= N 34 W	NE ¼ E	48
Variation same as in (1)	19 W	to left	19
True bearings NW ¾ W	= N 53 W	NNE ¼ E	= N 29 E

By Magnetic Chart, to Degrees and Points.

Beachy Head bore by compass	N 14°W	Afterwards	N 68°E
Deviation same as in (1)	20 W	to left	20 W
Magnetic Bearings NW by N	= N 34 W	NE ¼ E	= N 48 E

Draw a line 0 M, through Beachy Head, bearing NW by N magnetic, or NW ¾ W true, and another, 0 N, bearing NE ¼ E magnetic, or NNE ¼ E true, take 15 miles in the dividers, from the latitude scale at the side of the chart, and move a parallel ruler parallel to the course from Boulogne to the Royal Sovereign Shoal, until the dividers reach from M to N; then N is the position of the ship, and she is 9 miles distance from Beachy Head, and in Latitude 50° 37′N, Longitude 0° 6′E.

Exn. 9 D.

Rotation No.

Port of

EXAMINATION IN CHART.

ADDITIONAL FOR MASTERS.

(4.) Find the course to steer by compass from Boulogne to Royal Sovereign Shoal (see question 1) to counteract the effect of a current which set WSW magnetic, at the rate of 2 miles per hour, the ship making by log 4 miles per hour, also the distance the ship would then make good per hour towards the Shoal.

Answer.—Compass course N 34°W. Distance 5¼ miles.

Set of current, or tide, WSW magnetic	= S 67° 30′W	
Variation from chart	19 25 W	Allow to lef
Set of current, true	S 48 5 W	= SW ¼ W

Let A, on the chart, be the point from which the ship starts, and that she is bound along the line AC; as the scale of the chart is too small for this problem, and the longitude scale is one of equal parts, take 10 miles on it, to represent 1 mile in this problem; set off 2 miles, the rate of the tide, that is 20 miles on the longitude scale, from A to B, WSW magnetic, or SW ¼ W true; then take 4 miles, the rate of the ship, that is 40 miles on the scale, set one foot of the dividers on the point B, and let the other foot meet the line AC in the point C, join BC.

Then the direction of BC represents the course the ship must steer, to counteract the effect of the current, and the line AC represents the distance the ship would make good in an hour.

By the true compass the course from B to C is W by N ¾ N

True course W by N ¾ N	= N 70°W	
Variation	19 W	Allow to right
Magnetic course	N 51 W	= NW ¼ W
Deviation for ship's head NW ¼ W	17 W	Allow to right
Compass course	N 34 W	= NW by N

And by the scale the distance is 52½ miles, that is the distance made good per hour is 5¼ miles.

Note. If the dotted line AD be drawn parallel to BC, and CD parallel to BA, then the ship's head is always in the direction of AD, but she is always on the line AC; the candidate will not be required to draw the lines AD, DC.

(5.) On January 13th at 6h 0m A.M., being off Shoreham by reckoning, took a cast of the lead, required the correction to be applied to the depth obtained by the lead line before comparing it with the depth marked on the chart.

	d.	h.	m.			ft.	in.
Time of H.W. at Dover, Jan.	12	11	39	P.M.	Height of tide at Dover	19	1
Constant for Shoreham	+	0	22		Constant for Shoreham	—1	2
Time of H.W. at Shoreham	13	0	1	A.M.	Height of tide Shoreham	17	11
M.T.S.	13	6	0	A.M.	½ Mean Spring range ,,	9	0
Time after H.W. at Shoreham		5	59		Below mean level	8	11

	ft.	in.	
Half mean spring range at Shoreham	9	0	See page 226 Tide Table.
Table B.	—8	11	
Correction to be subtracted	0	1	from depth by lead

(See Bergen's Navigation page 238.)

(6.) What do you understand the small numbers to indicate that you see placed about the chart, and at what time of tide ?

A. Depth of water in fathoms, sometimes in feet. At low water ordinary springs.

(7.) What do the Roman numerals indicate that are occasionally seen near the coasts and in harbours ?

The time of high water at that place, at full and change of the moon.

(8.) How would you find, approximately, the time of high water at any place, the Admiralty tables not being at hand, nor any other special tables available ?

To the time of high water at full and change I would add 49 minutes for every day that has elapsed since the full or change of the moon; or to the time of the moon's meridian passage, corrected for longitude, add the port establishment, the sum, in either case, would be the P.M. tide required.

All the foregoing questions, and those on Form Exn. 9 C., must be answered, but this does not preclude the examiner from putting any other questions of a practical character or which the local circumstances of the port may require.

Signature.....

Date.....

Exn. 9 C.

Port of Sunderland.

Rotation No.

225

EXAMINATION IN CHART.

EXAMPLE II.

FOR ALL GRADES WHERE THE CHART IS USED.

The Candidate will be required to work out the following questions on either a true or magnetic chart, whichever may be handed to him by the Examiner; and also to determine whether the chart is a true or magnetic one, and whether it is for the Northern or Southern, or Eastern or Western Hemisphere.

(1.) Using a deviation card No.....find the course to steer by compass from Kelp Island to the Wolf Rock; and also the distance?

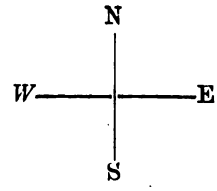
Answer.—Compass course NNE ½ E.
Distance 19¾ miles
Variation 15° 30'E
Deviation 20° 45'E

(2.) With the ship's head on the above named compass course, Point Pleasant bore by compass W by N ¾ N, and Beach Point bore N ¼ E by the same compass; find the ship's position?

Answer.—Latitude 51° 51'S
Longitude 58 7 W

(3.) With the ship's head as above Cape Pembroke bore by compass N by E ¼ E, and after continuing on the same course 14 miles it bore W by N ¼ N; find the position of the ship, and her distance from Cape Pembroke at the time of taking the second bearing?

Answer.—Latitude 51° 43'S
Longitude 57 37¼ W
Distance 8¼ Miles.



Solution of the preceding Questions.

(1). *By True Chart, to Points and Degrees.*

Kelp Point to Wolf Rock.

True course NE by E ¼ E = N	65°	E
Variation from Chart	16	E, Allow to left hand
Magnetic course NE ⅜ E = N	49	E
Dev. from left side of Card	21	E to left.
Compass course NNE ⅛ E = N	28	E

By Magnetic Chart, to Points and Degrees.

Magnetic course NE ⅜ E = N	49°	E
Deviation	21	E Allow to left
Compass course NNE ⅛ E = N	28	E

(2.) *By True Chart, to Points and Degrees.*

	Point Pleasant.		Beach Point.	
Compass bearing W by N ¼ N = N	70°	W	N ¼ E = N	8° E
Deviation same as in (1)	21	E	To right	21 E
Magnetic bearing NW ⅜ W = N	49	W	NNE ⅛ E = N	24 E
Variation same as in (1)	16	E	To right	16 E
True bearings NNW ⅞ W = N	33	W	NE ½ N = N	40 E

By Magnetic Chart, to Points and Degrees.

	Point Pleasant.		Beach Point.	
Compass bearing W by N ¼ N = N	70°	W	N ¼ E = N	8° E
Deviation same as in (1)	21	E	To right	21 E
Magnetic bearings NW ⅜ W = N	49	W	NNE ⅛ E = N	24 E

(3.) *By True Chart, to Degrees and Points.*

Pembroke Light.

Compass bearings N by E ½ E = N	17	E	and W by N ¼ N = N	76 W
Deviation same as in (1)	21	E	to right	21 E
Magnetic bearings NE ¾ N = N	38	E	NW ⅞ W = N	55 W
Variation same as in (1)	16	E	to right	16 E
True bearings NE ¼ E = N	54	E	NW ½ N = N	89 W

Exn. 9 D.

Port of Sunderland.

Rotation No. 225

EXAMINATION IN CHART.

(4.) Find the course to steer by compass from Kelp Island to the Wolf Rock, (see question 1) to counteract the effect of a current which set magnetic ENE, or true E ⅝ N, at the rate of 8 miles per hour, the ship making by log 10 miles per hour; also the distance the ship would make good per hour towards the Light?

Answer.—Compass course NNE
Distance 18 miles nearly.

For the sake of keeping the lines clear of each other, let A represent the point from which the Ship starts; draw AC parallel to the course from Kelp to Wolf Rock, and AB, ENE magnetic, or E ⅝ N true, 8 miles; with the dividers extended to 10 miles, set one foot at the point B and let the other meet the line AC in C, join AC; then

By the True Chart, to Points, Degrees and Minutes.

True course from B to C	NE ⅞ E	=	N 54° 51′E
Variation			15 30 E, to left
Magnetic course	NE ½ N	=	N 39 21 E
			17 30 E, to left
Compass course	NNE	=	N 21 51 E

To Find the Deviation.

Ship's head magnetic.	Dev.		
NE	20	20° 0′	
NE by N	15	—2 30	
	2)5	17 30	Dev. for NE ½ N
	2 30		

By the Magnetic Chart, to Points and Degrees.

Magnetic course from B to C	NE ½ N	=	N 39°
Deviation			18
Compass course	N by E ⅞ E	=	21

EXAMINATION IN CHART.

FOR ALL GRADES WHERE THE CHART IS USED.

EXAMPLE III.

(1.) Using deviation card No..... find the course to steer by compass from Cape Grisnez to Dover Pier End, also the distance.

Answer.—Compass course N 10° 49′W, or N by W
Distance 27½ miles
Variation 18° 20′W
Deviation 6 0 W

(2.) With the ship's head on the above-named compass course the South Sand Head Light Ship bore by compass NE by E ½ E, and Dover Pier End bore N by W ⅝ W by the same compass; find the ship's position.

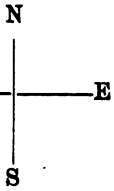
Answer.—Latitude 51° 4½′N
Longitude 1 22½ E

(3.) With the ship's head as above the Varne Light Ship bore by compass NW by W ½ W, and after continuing on the same course 10½ miles it bore NW ½ W; find the position of the ship, and her distance from Dover Pier End at the time of taking the second bearing?

Answer.—Latitude 51° 4′N
Longitude 1 23¾ E
Distance 8½ miles.

SOLUTIONS OF THE PRECEDING QUESTIONS.

(1.) *By True Chart, to Points, Degrees and Minutes.*



True course NW by N ½ N = N 35° 9′W
Variation from chart 18 20 W Allow to right hand

Mag. course N by W ½ W = N 16 49 W
Deviation from left side of card 6 0 W Allow to right hand

Compass course N by W = N 10 49 W

By Magnetic Chart, to Points and Degrees.

Magnetic course N by W ½ W = N 17°W
Deviation from left side 6 W to right

Compass course N by W = N 11 W

(2.) *By True Chart, to Points, Degrees and Minutes.*

	South Sand Head Light Ship		Dover Pier End
Compass course	N by E ½ E = N 61° 53′E;	N by W ⅝ W =	N 18° 17′W
Deviation same as in (1)	6 0 W;	to left	6 0
Magnetic courses	NE by E = N 55 53 E	NNW ⅛ W =	N 24 17 W
Variation same as in (1)	18 20 W;	to left	18 20 W
True courses	NE ⅝ N = N 37 33 E	NW ¼ N =	N 42 37 W

By Magnetic Chart, to Points and Degrees.

Compass courses	NE by E ½ E = N 62°E;	N by W ⅝ W =	N 18°W
Deviation same as in (1)	6 W;	to left	6
Magnetic course	NE by E = N 56 E	NNW ⅛ W =	N 24 W

Latitude 51° 4½′N. Longitude 1° 22½′E.

By True Chart to Points, Degrees and Minutes.

(3.) Varne Light Ship.

Compass bearings	NW by W ½ W = N 61° 53′W;	SW ½ W =	S 50° 38′W
Deviation same as in (1)	6 0 W	to left	6 0 W
Magnetic bearings	WNW = N 67 53 W;	SW =	S 44 38 W
Variation same as in (1)	18 20 W	to left	18 20 W
True bearings	W ⅝ N = N 86 13 W	SSW ⅝ W =	S 26 18 W

By Magnetic Chart, to Points and Degrees.

Compass bearing	NW by W ½ W = N 62 W;	SW ½ W =	S 51°W
Deviation same as in (1)	6 W;	to left	6 W
Magnetic bearings	WNW = N 68 W	SW =	S 45 W

Exn. 9 D.

Rotation No.
226

Port of

EXAMINATION IN CHART.

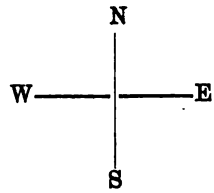
ADDITIONAL FOR MASTERS.

(4.) Find the course to steer by compass from Cape Grisnez to Dover (see question 1) to counteract the effect of a current which set ENE magnetic, or NE $\frac{3}{8}$ E true, 3 miles per hour, the ship making by log 10 miles per hour, also the distance the ship would then make good per hour towards Dover?

SOLUTION OF THE PRECEDING QUESTION.

Set off 3 miles, the rate of the tide taken from the scale, from A to B, NE $\frac{3}{8}$ E true, or ENE magnetic, then take 10 miles, the rate of the ship, with the dividers from the same scale, set one foot of the dividers on the point B, and let the other foot meet the line AC in the point C; join BC.

Then BC represents the course the ship must steer to counteract the tide, and AC represents the distance the ship would make good towards Dover in an hour.



By the true Chart; to Points, Degrees and Minutes.

True course from B to C is	N W $\frac{3}{8}$ W = N	52°	2′W
Variation; from chart		18	20 W to right
Magnetic course	NW by N = N	33	42 W
Deviation, for NW by N		12	0 W to right
Compass course	N by W $\frac{7}{8}$ W = N	21	42 W

By the Magnetic Chart, to Points and Degrees.

Magnetic course from B to C, NW by N =	N	34°W
Deviation from NW by N		12 W to right
Compass course NNW =	N	22 W

And by applying AC to the scale with the dividers, the distance made good towards Dover is 9¾ miles per hour.

Exn. 9 C.

Port of Sunderland.

Rotation No.
227

EXAMINATION IN CHART.

EXAMPLE IV.

FOR ALL GRADES WHERE THE CHART IS USED.

(1.) Using deviation card No..... find the course to steer by compass from Dungeness to the Cape Alprech; and also the distance?

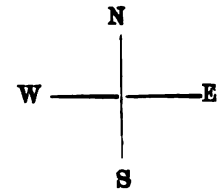
Answer.—Compass course SE $\frac{3}{8}$ E. or S 49° 38′E
Distance 27 miles
Variation 18° 25′ W
Deviation 7 30 E

(2.) With the ship's head on the above named compass course, Grisnez bore E by N $\frac{5}{8}$ N, and the Varne bore N $\frac{1}{8}$ W by the same compass; find the ship's position?

Answer.—Latitude 50° 46¼′ N
Longitude 1 20¼ E

(3.) With the ship's head as above, the Varne bore E $\frac{1}{8}$ N, and after continuing on the same course 11 miles it bore N by E $\frac{7}{8}$ E; find the position of the ship, and her distance from the Varne at the time of taking the second bearing?

Answer.—Latitude 50° 48¾′ N
Longitude 1 14¼ E
Distance 7¼ miles.



Solution of the preceding Questions.

(1.) *By True Chart, to Points, Degrees and Minutes.*

Dungeness to Cape Alprech.

True course SE by E ⅛ E = S 60° 28'E
Variation from chart 18 25 W, to right

Magnetic course SE ¼ S = S 42 8 E
Dev. from left side of Card 7 30 E to left

Compass course SE ¼ E = S 49 38 E

To find Deviation for SE ¼ S.

Course.	Deviation.	
SE	9°E	9° 0' E
SE by S	8	—1 30
	4)6	7 30 E
	1 30	

By Magnetic Chart, to Points and Degrees.

Magnetic course SE ¼ S = S 42°E
Deviation 8 E to left

Compass course SE ¼ E = S 50 E

(2.) *By the True Chart, to Points, Degrees and Minutes.*

	Cape Grisnez.	Varne.
Compass bearing E by N ⅛ N =	N 71° 48'E,	N ¼ W = N 1° 24'W
Deviation same as in (1)	7 30 E	To right 7 30 E
Magnetic bearing E by N =	N 79 18 E	N ¼ E = N 6 6 E
Variation same as in (1)	18 25 W	To left 18 25W
True bearings NE by E ⅛ E =	N 60 48 E	N by W ¼ W = N 12 19W

By Magnetic Chart, to Points and Degrees.

Compass bearing E by N ⅛ N =	N 72°E	N ¼ W = N 1° W
Deviation same as in (1)	8 E to right	8 E
Mag. Bearings E ⅛ N =	N 80 E	N ⅛ E = N 7 E

(3.) *By the True Chart, to Points, Degrees and Minutes.*

Varne Compass bearings E $\frac{1}{8}$ N =	N88°	36'E,	and N by E $\frac{7}{8}$ E =	N21°	6'E
Deviation same as in (1)	7	30 E	to right	7	30 E
	N 96	6 E	NNE $\frac{1}{8}$ E =	N 28	36 E
Variation same as in (1)	18	25 W	to left	18	25 W
True bearings E by N $\frac{1}{8}$ N =	N 77	41 E	N $\frac{7}{8}$ E =	N 10	11 E

By Magnetic Chart, to Points and Degrees.

Varne compass bearings E $\frac{1}{8}$ N =	N 89°	E,	and N by E $\frac{7}{8}$ E =	N 21°	E
Deviation same as in (1)	8	E	to right	8	E
	N 97	E	NNE $\frac{1}{8}$ E =	N 29	E
	180				
Magnetic Bearings E $\frac{1}{8}$ S =	S 83	E			

Exn. 9 D.

Port of Sunderland.

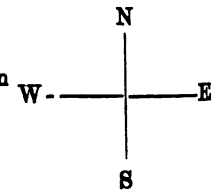
Rotation No. 227

EXAMINATION IN CHART.

ADDITIONAL FOR MASTERS.

(4.) Find the course to steer by compass from Dungeness to Cape Alprech, (see question 1) to counteract the effect of a current which set SW ⅛ W true, or WSW magnetic, at the rate of 3 miles per hour, the ship making by log 9 miles per hour; also the distance the ship would then make good per hour towards Cape Alprech ?

SOLUTION OF THE PRECEDING QUESTION.



(4.) Draw the figure as in the preceding examples, then

By The True Chart, to Points, Degrees and Minutes.

True course from B to C, E by S =	S 78° 45′ E	
Variation from chart	18 25	W to right
Mag. course SE by E ⅛ E =	S 60 20	E
Deviation to left	15 53	E
Compass course E by S ¼ S =	S 76 18	E

To Find the Deviation.

Course.	Dev.	
SE by E	14	14° 0′
ESE	19	+1 53
	5	15 53
	60	
	8)300	
	37·5	
	8	
	6,0)11,2·5	
	1 52·5	

By the Magnetic Chart, to Points and Degrees.

Magnetic course	SE by E ⅛ E	=	S 60° East
Deviation			16 E to left
Compass course	E by S ¼ S	=	S 76 E

Distance AC = 7½ miles made good per hour from Dungeness towards Cape Alprech.

EXERCISES.

FOR ALL GRADES WHERE THE CHART IS USED.

(1.) Using deviation card No..... Find the course to steer by compass from the South Foreland High Light House to Calais Pier End; also the distance?

Answer.—Compass Course S 49° 38′ E, or SE ⅛ E.
Distance 20½ miles
Variation 18° 20 W
Deviation 7 30 E

(2.) With the ship's head on the above named compass course, Dover Castle, bore, W by N ⅛ N, the South Sand Head Light Ship bore NE ⅛ N by the same compass; find the ship's position?

Answer.—Latitude 51° 6′¾ N
Longitude 1 26″ E

(3.) With the ship's head as above the South Sand Head Light Ship bore by compass E by N ⅛ N and after continuing the same course 5¾ miles, it bore N by W ⅛ W; find the position of the ship, and her distance from the Light Ship at the time of taking the second bearing?

Answer.—Latitude 51° 4¾′ N
Longitude 1 31½ E
Distance 4¾ miles.

ADDITIONAL FOR MASTERS.

(4.) Find the course to steer by compass from the South Foreland to Calais (see question 1,) to counteract the effect of a current, or tide, which set SW ⅛ S true, SW by W magnetic, at the rate of 2½ miles per hour, the ship making by log 11 miles per hour; also the distance the ship would then make good per hour towards Calais?

Answer.—Compass Course S 70° 12′ E, or E by S ¼ S
Distance 10½ miles per hour

II.—EXERCISES IN EXAMINATION IN CHART.

FOR ALL GRADES WHERE THE CHART IS USED.

(1.) Using deviation card No..... find the course to steer by compass from the South Foreland to Dungeness; also the distance?

Answer.—Compass Course S 84° 38′ W; or W ¼ S
Distance 20½ miles
Variation 18° 25′ W
Deviation 17 0 W

(2.) With the ship's head on the above named compass course the South Foreland High Light House bore by compass E by N ¼ N, and the Varne Light Ship bore S by W ¼ W by the same compass; find the ship's position?

Answer.—Latitude 51° 1¼′ N
Longitude 1 18¾ E

(3.) With the ship's head as above, the Varne bore by compass S ¼ W, and after continuing on the same course 7¾ miles, it bore SE ¼ E; find the position of the ship, and her distance from the Varne at the time of taking the second bearing?

Answer.—Latitude 50° 56¾′ N
Longitude 1 2¾ E
Distance 9¼ miles

ADDITITIONAL FOR MASTERS.

(4.) Find the course to steer by compass from the South Foreland to Dungeness (see question 1,) to counteract the effect of a current which set SW by W ¼ W magnetic or SW ⅜ W true, at the rate of 8 miles per hour, the ship making by log 8 miles per hour; also the distance the ship would then make good per hour towards Dungeness?

Answer.—Compass Course S 88° 57′; or W ¼ S
Distance 11 miles

III.

FOR ALL GRADES WHERE THE CHART IS USED.

(1). Using deviation card No..... find the course to steer by compass from Cape Alprech to Dungeness; also the distance?

Answer.—Compass Course N 27° 8′ W, or NNW ⅜ W
Distance 26 miles
Variation 18° 25′ W
Deviation 15 0 W

(2.) With the ship's head on the above named compass course Cape Grisnez bore E by N, and the Varne Light Ship bore by the same compass N ¼ E; find the ship's position?

Answer.—Latitude 50 46′ N
Longitude 1 25 E

(3.) With the ship's head as above, Cape Grisnez bore by compass NE ¼ E, and after continuing on the same course 12 miles, it bore ESE; find the position of the ship, and her distance from the Cape at the time of taking the second bearing?

Answer.—Latitude 50° 49¼′ N
Longitude 1° 14 E
Distance 13¾ miles

ADDITIONAL FOR MASTERS.

(4.) Find the course to steer by compass from Cape Alprech to Dungeness (see question 1,) to counteract the effect of a current which set N by E ⅝ E true, or NE by N magnetic, at the rate of 3 miles per hour, the ship making by log 8¼ miles per hour; also the distance the ship would then make good per hour towards Cape Alprech?

Answer.—Compass Course N 42° 44′ W, NW ¼ W
Distance 8⅛ miles

IV.

FOR ALL GRADES WHERE THE CHART IS USED.

(1.) Using deviation card No..... find the course to steer by compass from Calais Pier End towards the South Foreland High Light; also the distance?

Answer.—Compass Course N 27° 8′W, or NNW ⅝ W.
Distance 20¼ miles
Variation 18° 20′W
Deviation 15 0 W

(2.) With the ship's head on the above named Compass Course Gravelines Light House bore by Compass SE ¼ E, and Cape Grisnez Light House bore SW by W ⅞ W by the same Compass; find the ship's position?

Answer.—Latitude 51° 0¾′ N
Longitude 1 43½ E

(3.) With the ship's head as above, Cape Grisnez bore W ⅝ S and after continuing the same course 9 miles it bore SW ⅝ S; find the position of the ship, and her distance from the Cape at the time of taking the second bearing?

Answer.—Latitude 51° 4′ N
Longitude 1 36 E
Distance 11¼ miles.

ADDITIONAL FOR MASTERS.

(4.) Find the course to steer by compass from Calais to the South Foreland (see question 1) to counteract the effect of a current, or tide, which set E by N ⅝ N true, or East magnetic, at the rate of 8 miles per hour, the ship making by log 10 miles per hour; also the distance the ship would then make good per hour towards the Foreland?

Answer.—Compass Course N 37° 8′ W or NW ⅝ N
Distance 7¼ miles.

V. EXAMINATION IN CHART.

FOR ALL GRADES WHERE THE CHART IS USED.

(1.) Using deviation card No..... find the course to steer by compass from Dungeness to the South Foreland; also the distance.

Answer.—Compass Course N 17° 27′ E, or N by E ½ E
Distance 20½ miles
Variation 16° 0′E Assumed.
Deviation 14 22 E

(2.) With the ship's head on the above named Compass course, South Foreland bore by compass NE ½ E and the Varne Light Ship bore SE by the same Compass; find the ship's position?

Answer.—Latitude 51° 0½′ N
Longitude 1 9 E

(3.) With the ship's head as above the Varne bore by compass NE by E ½ E, and after continuing on the same course 12 miles, it bore SE ½ E, find the position of the ship, and her distance from the Varne at the time of taking the second bearing?

Answer.—Latitude 51° 3′ N
Longitude 1 13½ E
Distance 7½ miles

ADDITIONAL FOR MASTERS.

(4.) Find the course to steer by compass from Dungeness to the South Foreland (see question 1) to counteract the effect of a current which set SE ½ E true, or SSW ⅞ W magnetic, at the rate of 2½ miles per hour, the ship making by log 10 miles per hour towards the Foreland?

Answer.—Compass Course N 17° 27′ E, or N by E ½ E
Distance 7½ miles

VI.

FOR ALL GRADES WHERE THE CHART IS USED.

(1.) Using deviation card No.....find the course to steer from the Needles to Cape La Heve; also the distance?

Answer.—Compass Course S 19° 1′E, or S by E ½ E
Distance 94 miles
Variation 20° 10′ W
Deviation 8 0 W

(2.) With the ship's head on the above named compass course the Needles bore N by W ¾ W and St. Catherine's bore E ¼ S by the same compass; find the ship's position ?

Answer.—Latitude 50° 33′ N
Longitude 1 25 W

(3.) With the ship's head as above St. Catherine's Light bore SE by E ¾ E, and after continuing the same course 16 miles it bore N ¼ E; find the position of the ship and her distance from St. Catherine's at the time of taking the second bearing ?

Answer.—Latitude 50° 23′ N
Longitude 1 10½ W
Distance 12¼ miles

ADDITIONAL FOR MASTERS.

(4.) Find the course to steer by compass from the Needles to Cape La Heve to counteract the effect of a current, or tide, which set E ¾ N true, or E by S magnetic, at the rate of 2 miles per hour, the ship making by log 8 miles per hour; also the distance the ship would then make good per hour towards the Cape ?

Answer.—Compass Course S 6° 46′ E, S ⅝ E
Distance 9 miles per hour.

VII.

FOR ALL GRADES WHERE THE CHART IS USED.

(1.) Using deviation card No..... find the course to steer by compass from Cape La Heve to the Needles; also the distance ?

Answer.—Compass Course N 14° 1′ W; or N by W ¼ W
Distance 94 miles
Variation 20° 10 W
Deviation 8 0 W

(2.) With the ship's head on the above named compass course Fecamp Light House, bore by compass SE by E ¼ E, and Cape La Heve Light House bore S by E ¼ E by the same compass; find the ship's position ?

Answer.—Latitude 49° 47′ N
Longitude 0 19¼ W

(3.) With the ship's head as above Cape d'Antifer by compass, bore E by N ¼ N, and after continuing on the same course, 25 miles, it bore SE ¾ S; find the position of the ship, and her distance from the Cape at the time of taking the second bearing ?

Answer.—Latitude 49° 52¼′ N
Longitude 0 29 W
Distance 27 miles

ADDITIONAL FOR MASTERS.

(4.) Find the course to steer by compass from Cape La Heve to the Needles (see question 1,) to counteract the effect of a current, or tide, which set W ¼ S true, or W by N magnetic, at the rate of 2 miles per hour, the ship making by log 7 miles per hour; also the distance the ship would then make good per hour towards the Needles?

Answer.—Compass Course N 5° 28′ W; or N 2¼ W
Distance 8 miles, nearly

VIII.

FOR ALL GRADES WHERE THE CHART IS USED.

(1.) Using deviation card No..... find the course to steer by compass from Cape La Heve to Cape Barfleur; also the distance?

Answer.—Compass Course N 38° 56′ W; or NW ¼ N
Distance 52 miles
Variation 20° 10′ W
Deviation 18 15 W

(2.) With the ship's head on the above named compass course Cape Barfleur bore by compass SSE ⅜ E, and Cape La Hágue, bore by the same compass W ⅜ S; find the ship's position?

Answer.—Latitude 49° 50′ N
Longitude 1 46 W

(3.) With the ship's head as above, Cape Barfleur bore by compass NW ⅜ W, and after continuing on the same course, 17 miles, it bore S ⅜ E; find the position of the ship, and her distance from Cape Barfleur at the time of her taking the second bearing?

Answer.—Latitude 49° 45′ N
Longitude 1 20 W
Distance 4¾ miles

ADDITIONAL FOR MASTERS.

(4.) Find the course to steer by compass from Cape La Heve to Cape Barfleur to counteract the effect of a current which set W by N ⅛ N true, or NW by W ⅛ W magnetic, at the rate of three miles per hour, and the ship was making by log 10 miles per hour; also the distance the ship would then make good per hour towards Cape Barfleur?

Answer.—Compass Course N 38° 56′ W; or NW ¼ N
Distance 13 miles per hour.

Note.—In this example the current set in the same direction as the ship sailed; hence the sum of the rate of the current and the rate of the ship is the distance made good per hour.

Rotation No.

*Port of*_____

EXAMINATION PAPER II.

TO BE USED BY A CANDIDATE FOR A CERTIFICATE OF COMPETENCY AS A

SECOND MATE.

This paper to be used at the above port this _____ *day of* _____

Space for Minor Corrections.

1.—Multiply 50000 by 6000 by common logarithms

50000	log.....	4·698970
6000	log.....	3·778151
300 000 000	log.....	8·477121

In this question, the decimal part of the log of the first four figures, namely 5000, is 698970, which is also the decimal part of the logs of the numbers, 5, 50, 500, 5000, 50 000, and so on; but by Bergen's Navigation, page 18, Article 18; the index of 50 000 is 4.

In like manner, 477121 is the decimal part of the log of 8, and also of all the numbers formed by affixing ciphers to 8; and as the index of the product is 8, ciphers must be affixed to 8000 so as to make up 9 integers.

2.—Divide 6·394 by 2·43 by common logarithms.

6·394	log.....	0·805773
2·43	log.....	0·385606
2·631	log.....	0·420167

Here, by Bergen's Navigation, Article 18, the indices are all 0, and therefore there must be one integer to the left of the decimal point.

PAPER II.

EXAMINATION FOR SECOND MATES.

Space for minor corrections.

N

W——+——E

S

	N. 68°W.
V 25°W. D 9 W.	34 W.
	N. 102 W.
	180
	S. 78 W.
	N. 68°W.
L	11
	N. 79 W.
V 25°W. D 18 E.	7 W.
	N. 86 W.
	N. 79°W.
L	8
	N. 87 W.
V 25 W. D 19 E.	6 W.
	N. 93 W.
	180
	S. 87 W.
	S. 90°W.
L	8
	S. 82 W.
V 25°W. D 22 E.	3 W.
	S. 79 W.
	N. 39 E.
L	8
	N. 47 E.
V 25 W. D 9 W.	34 W.
	N. 13 E.
	N. 68°E.
L	14
	N. 82 E.
V 25 W. D 11 W.	36 W.
	N. 46 E.
	N. 73 W.
	6
L	
	N. 79 W.
V 25°W. D 18 E.	7 W.
	N. 86 W.
	N. 68°W.
V	25 W.
	N. 93 W.
	180
	S. 87 W.

Hors.	Courses.	Knts.	10ths	Winds.	Lee-way.	Dev.	Remarks.
1	N 68°W	4	3	N.	11°	18°E	
2		4	4				A point St.
3		4	5				in Lat. 65° 29′ N.
4		5	8				Long. 178° 45′ W.
5	N 79°W	5	8	N. by W.	8°	19°E	bearing by Compass S 68°E
6		6	1				
7		6	2				
8		6	9				
9	W	6	9	N.N.W.	8°	22°E	(Ship's Head N39°E Deviation as per log)
10		6	8				Dist. 20 miles.
11		6	2				
12		6	1				
1	N 39° E	5	7	NNW ½ W	8°	9°W	Variation 25°W
2		5	3				
3		5	5				
4		5	5				
5	N 68° E	4	7	N.	14°	11°W	A current set Correct Magnetic N 68°W
6		4	6				
7		4	5				
8		4	2				
9	N 78°W	4	3	N. ½ W.	6°	18°E	13 miles from the time the departure was taken to the end of the day.
10		4	7				
11		4	8				
12		5	2				

Correct the Courses for Deviation, Variation, and Leeway, and find the Course and Distance from the given Point, and the Latitude and Longitude in, by Inspection.

Corrected Courses.	Dist.	N.	S.	E.	W.
S 78°W	20		4·2		19·6
N 86 W	19	1·3			19·0
S 87 W	25		1·3		25·0
S 79 W	26		5·0		25·5
N 13 E	22	21·4		4·9	
N 46 E	18	12·5		12·9	
N 86 W	19	1·3			19·0
S 87 W	13		0·7		13·0
		36·5	11·2	17·8	121·1
		11·2			17·8
		25·3			103·3

Lat. left	65°	29′	N	Long. left	178°	45′	W
Diff. lat		25	N	Diff. long.	4	12	W
Lat. in	65	54	N	Long. in	182	57	W
	2)131	23			360	0	W
Mid. lat.	65	41		or long in	177	3	E

TO FIND THE DIFF. LONGITUDE BY INSPECTION.

Mid lat. 65° Dep. 103·1 in lat. col. give 244 in dist col.
„ 66 Dep. 103·8 „ „ 254 „

Here the lat. is high and the mid lat. is near 65½ in this case proceed as annexed.

4)10 Subtract.
2·5

6,0)25,1·5

Diff. long. 4,11·5

TO FIND THE COURSE AND DIST. BY INSPECTION.

Enter Table II. with dep. 103·8 and diff. lat. 25·8; the nearest numbers to hem are dep. 103·8 and lat. 25·9, which give the course 76° and dist. 1 07.

Hence we have course N 76° W, distance 107 miles.

In this question it would be more correct and less trouble to find the diff. lon. as follows.

Mid. lat.	65° 41′	sec.	0·385335
Dep.	103·8	log	2·014100
6,0)25,0·9		log	2·399435
Diff. long.	4 10·9		

By logs Course N 76° 24′ W, distance 106·8 miles.

PAPER II.

EXAMINATION FOR SECOND MATES.

Space for Minor Corrections.

4.—1877, March 20th, in longitude 172° W, the observed meridian altitude of the Sun's Lower Limb was 47° 18′ bearing South, index error 0, height of eye 22 feet.

Required the Latitude.

	d.	h.	m.	s.
A.T.S. Mar.	20	0	0	0
Long. W	+	11	28	0
A.T.G. Mar.	20	11	28	0

11·5

Long. 172° 0′ W
4
6,0)68,8 0
11 28 0

Var. 59″·24 / 11·5 / 29620 / 65164 / 6,0)68,1·260 / 11 21·2

	°	′	″
	0	0	20 N
	+11	21	
	0	11	41 N

Obs. alt.	47°	18′	0″	S
Dip.		4	37	
	47	13	23	
Corr.	—	0	48	
	47	12	35	
Sem.	+	16	5	
True alt.	47	28	40	
	90	0	0	
Z. D.	42	31	20	N
Dec.	0	11	41	N
Latitude	42	43	1	North

5.—In latitude 42° 18′ the departure made good was 54 miles.

Required the difference of Longitude by parallel sailing.

Lat.	42° 18′	Sec.	0·130985
Dep.	54	log.	1·732894
Diff. long.	73·01	log.	1·863879

The Candidate should sign his name in full at the foot of every page.

PAPER II.

EXAMINATION FOR SECOND MATES—Continued.

Space for Minor Corrections.

6.—Required the Course and Distance from A to B by calculation on Mercator's Principle.

Lat. of A 58° 0′ N Long. 0° 89′ E
Lat. of B 54° 11′ N Long. 7° 53′ E

A Lat.	58	0 N	m. pts. 4294	Long. 0	89 E
B Lat.	54	11 N	m. pts. 3883	Long. 7	53 E
	3	49	m.d.l. 411		7 14
		60			60
Diff. lat.	229	S		Diff. long.	434 E

Diff. long. 434	log. +10		12·637490
M.d.l. 411	log.		2·613842
Course 46° 34′	tan.		10·023648
Course 46° 34′		sec.	0·162721
D. lat. 229		log.	2·359835
Dist. 333·1		log.	2·522556

Course S 46° 34′ E. Distance 333·1 miles.

Rotation No.

Exn. 5.

*Port of*_____

EXAMINATION PAPER II.

TO BE USED BY A CANDIDATE FOR A CERTIFICATE OF COMPETENCY AS A

SECOND MATE.

*To be used at the above Port this*_____*day of*_____18

N.B.—A Candidate for Second Mate's Certificate of Competency will be required to work the Questions in Paper Exn. 4, *in addition to the Questions in this Paper.*

Space for minor Corrections.

1.—1880. June 2nd. Find the time of High Water at Bordeaux, A.M. and P.M.

	d.	h.	m.		d.	h.	m.	
Stan. Brest, June	2	11	32	A.M.	1	10	59	P.M.
Const. Bordeaux	+	3	3		+	3	3	
H.W. Bordeaux	2	2	35	P.M.	2	2	2	A.M.

2.—1877. April 14th. At 6h. 42m. A.M., Appt. T. Ship, in latitude 47° 9′, longitude 89° 16′ E. The Sun's Magnetic Amplitude was E by N.

Required the True Amplitude, and Error of the Compass; and supposing the Variation to be 25° 10′ W, required the Deviation of the Compass for that position of the Ship's Head.

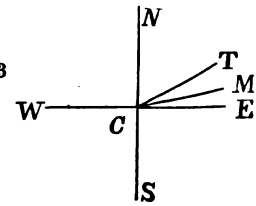
	d.	h.	m.	s.	
A.T.S., April ..	14	6	42	0	A.M.
	—	1+12			
A.T.S., April ..	13	18	42	0	
Longitude E ..	—	5	57	4	
A.T.G., April..	13	12	44	56	
	14	0	0	0	
		11	15	4	T left of M
		11	3		error W

See page 113 Bergen's Navigation.

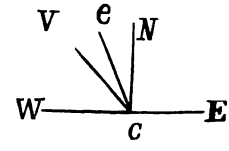
Long..... 89° 16′ E
4

6,0)35,7 4

5 57 4



Var.	Dec.						
53″·84	9	33	6 N	Lat.....	47	9	sec..... 0·167439
11·3	—	10	8	Dec.....	9	23	sin..... 9·212291
16152	9	22	58 N	True amp. E	13	52 N	sin..... 9·379730
59224				Mag amp. E	11	15 N	
6,0)60,8·392				Err.	2	37 W	
10 8·3				Var.	25	10 W	
				Deviation ..	22	33 E	



e right of V.
Deviation E.

See page 113 Bergen's Navigation.

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PAPER II.

EXAMINATION FOR SECOND MATES—Continued.

Space for Minor Corrections.

To find the daily rate.

	d.	s.
Dec. 8	2	Sl.
Dec. 18	20	Fast
10)	22	
	2·2	

Gaining daily.

	Var.
	59″·24
	9·5
	29620
	53316
6,0)56,2·780	
9	22·7

Cos.

76° 18′ 0″	9·374452
	— 458
76 18 53	9·373994
Diff.	864
	53
	2592
	4320
	457,92

Sin.

45° 10′ 0″	9·850745
	+ 36
45 10 17	9·850781
Diff.	209
	17
	1463
	209
	35,53

3.—1877. March 19th, P.M., at Ship in latitude 31° 20′ N. The observed altitude of the Sun's L.L. was 30° 57′ 40″, height of the eye 14 feet. Time by a Chronometer, March 19d. 14h. 32m. 17s., which was 2s. slow for mean noon at Greenwich, on December 8th, 1876, and on December 18th, 1876 was 20s. fast.

Required the longitude of Chronometer.

	d.	h.	m.	s.		d.	
T Chron., Mar...	19	14	32	17	Dec...	31	15 hours
fast	—			20	Dec...	18	·04
	19	14	31	57	Dec...	13	91·6.0
gained	—		3	22	Jan...	31	2·2
					Feb...	28 h.	
M.T.G., Mar. ..	19	14	28	35	Mar ..	19 15	1832
	20	0	0	0			1832
						91 15	
Time from nearest noon.....		9	31	25		—— 6,0)	20,1·52
		9	5			Acc. rate	3 22,1·5

Dec.	Eq. T. m. s.	Var.
° ′ ″ 0 0 13 N	+ 7 32·80	0·752
0 9 23 S	+ 7·14	9·5
0 9 10 S	+ 7 39·94	3760
90 0 0		6768
P.D. 90 9 10		7·1440

Obs. alt....	30 57 40	Alt.	31 8 36			
Dip.	— 3 41	Lat.	31 20 0	sec...	0·068463	
		P.D.....	90 9 10	cosec.	0·000000	
	30 53 59					
Corr.	— 1 28		152 37 46			
	30 52 31	Half sum ..	76 18 53	cos ..	9·373994	
Sem.	+ 16 5	Diff.	45 10 17	sin...	9·850781	
True alt...	31 8 36			log...	9·293238	
			h. m. s.		0	
		H.A.....	3 30 29			s.
		Eq. T.	+ 7 40			3 = 1
			d.			
	M.T,S., Mar...		19 3 38 9			
	M.T.G., Mar...		19 14 28 35			
			10 50 36			
			60 120			
			4)650 146			
					120	
	Longitude..		162 36		30 West	

The Candidate should sign his name in full at the foot of every page.

Exn. 6.

Rotation No.

Port of _____

EXAMINATION PAPER II.

TO BE USED BY A CANDIDATE FOR A CERTIFICATE OF COMPETENCY AS AN

ONLY MATE.

To be used at the above port this _____ *day of* _____ 18

N.B.—A Candidate for an Only Mate's Certificate of Competency will be required to work the Questions in Papers Exn. 4 and Exn. 5, in addition to the Questions in this paper.

Space for Minor Corrections.

1.—1877, June 13th, mean time at Ship 8h 45m P.M. in latitude 42° 2′ S, longitude 27° 23′ W. The Sun's bearing by Compass NW ¾ W, altitude L.L. 6° 28′. Height of the eye 18 feet. Required the True Azimuth, and Error of the Compass; and supposing the Variation to be 5° 20′W, required the Deviation of the Compass for that position of the Ship's head; both from the Altitude and by the Time Azimuth Tables.

	d.	h.	m.	s.		Long.	°	′	
M.T.S. June....	13	8	45	0 P.M.			27	23	W
Longitude W .. +		1	49	32				4	
M.T.G. June....	13	5	34	32			6,0)10,9	32	
			5·6					1 49	32

Var. 8″·09 5·6 — 4854 4045 — 45·304

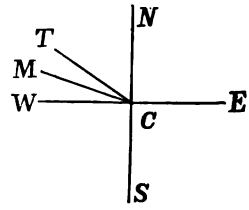
	°	′	″		
	23	14	45	N	Obs. alt..... 6 28 0
	+		45		Dep. .....— 4 11
	23	15	30	N	6 23 49
	90	0	0		Cor. .....— 7 47
P.D.	113	15	30		6 16 2
					Sem.....+ 15 47
					True alt..... 6 31 49

BY SUN'S ALTITUDE.

Alt.....	6	31	49
Lat.	42	2	0
P.D.	113	15	30
	2)161	49	19
Half Sun	80	54	39
Diff.....	32	20	51
Half az...	25	9	31
			2
True az. N	50	19	2 W
Mag. az. N	53	26	W
Err.....	3	7	E
Var.....	5	20	W
Deviation	8	27	East.

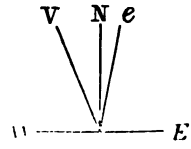
sec 0·002830
sec 0·129154
cos 9·198302
cos 9·926751
2)19·257037
sin 9·628518
378
448)14000(31
1344
560
448

Figure for error.



T to right of M
Error E

Figure for deviation



e right of V
Deviation East.

The Candidate should sign his name in full at the foot of every page.

PAPER II.

EXAMINATION FOR ONLY MATES—Continued.

Space for Minor Corrections.

BY AZIMUTH TABLES.

	h.	m.	s.	
M.T.S.....	3	45	0	P.M.
Eq. T.....	+		10	
A.T.S.....	3	45	10	P.M.

A.T.S. 3h. 44m. lat. 42° S and dec. 23° N.

Give True Az....	S	129°	46′	W
		180	0	
or True Az.	N	50	14	W
Mag. Az.	N	53	26	W
Err.		3	12	E
Var.		5	20	W
Deviation.....		8	32	East.

2.—1877, April 14th, P.M. at Ship, in lat. by account 37° 33′ S, long. 178° 16′ E. The observed altitude of the Sun's L.L. North of the observer was 42° 12′, height of eye 22 feet. Time by watch, April 15d. 0h. 22m. 4s., which had been found to be 45m. 12s. fast of apparent time at ship.

The difference of Longitnde made to the West was 32·5 after the error on Apparent Time at Ship was determined.

Required the latitude by the Reduction to the Meridian.

	d.	h.	m.	s.
T.W., April ..	15	0	22	4
fast	—		45	12
	14	23	36	52
D.L.W.	—		2	10
A.T.S., Apr...	14	23	34	42
Long. E	—	11	53	4
A.T.G., Apr..	14	11	41	38
		11.	7	

D.L. ..	32′·5			
	4			
6,0)13,0·0				
	2m.	10s.		

Long. ..	178°	16′	E
		4	
6,0)71,8	4		
	11	53	4

	h.	m.	s.
	24	0	0
	23	34	42
T. from noon	25	18	

	9°	33′	6″	N
	+ 10	30		
	9	43	36	N

Obs. alt...	42°	12′	0″	N
Dip.	—	4	37	
	42	7	23	
Corr.	—	0	58	
	42	6	25	
Sem.	+	15	58	
True alt..	42	22	23	

Var.	
53″·84	
11·7	
37688	
59224	
6,0)62,9·928	
10 29·9	

The Candidate should sign his name in full at the foot of every page.

Rotation No.

Exn. 7.
(late E. F. 4.) *Port of* _____

EXAMINATION PAPER II.

TO BE USED BY A CANDIDATE FOR A CERTIFICATE OF COMPETENCY AS A

MASTER ORDINARY.

To be used at the above Port this _____ *day of* _____ 18

N.B.—A Candidate for an Ordinary Master's Certificate of Competency will be required to work the Questions in Papers Exn. 4, Exn. 5, and Exn. 6, in addition to the Questions in this Paper.

Space for Minor Corrections.

1.—1877, February 11th, the observed Meridian Altitude of the Star α Pegasi (Markab) bearing South, was 58° 47′ 10″, I.E. 1′ 40″, height of the eye 22 feet.

Required the Latitude.

Obs. alt.....	58°	47′	10″	S
I.E.....	+	1	40	
	58	48	50	
Dip.....	—	4	37	
	58	44	13	
Ref.	—	0	35	
True lat. ...	58	43	38	
	90	0	0	
Z. D.....	31	16	22	N
Dec.....	14	32	36	N
Latitude ...	45	48	58	North

The Candidate should sign his name in full at the foot of every page.

ON SOUNDINGS.

To find the correction to be applied to the depth obtained by the lead line when the place is a Port of Reference.

EXAMPLE I.—1881, January 20th, at noon, off Sheerness, took a cast of the lead; required the correction to be applied to it.

	d.	h.	m.			ft.	in.
T.H.W. Sheerness, Jan.	20	8	38	P.M.	Height tide, Sheerness	15	4
M.T.S. Jan.	20	0	0	noon	½ mean spring range —	8	0
Time from H W.		8	38		above mean level	7	4

	ft.	in.
½ Mean spring range	8	0
Correction from Table B.—	1	10
Answer	6	2

; to be subtracted from the depth shown by the lead, in order to find the depth marked on the chart.

Notes.—The time of high water and the height of the tide at Sheerness, on the 20th January, are found in the "Admiralty Tide Tables," page 3rd, and Table B is found in page 98.

Enter Table B with the difference between the time of high water, and the time of the cast and the difference between the height of the tide and ½ mean spring range, and apply the result to the ½ mean spring range according to the sign + or — given in the Table.

The quantity thus found must be subtracted from the depth given by the lead, to find the depth marked on the chart.

ON INTERPOLATION.

The quantities in Table B are only given for every foot, between 8 and 24, above the mean level of the sea, and for every 30 minutes between 0h. and 6h. If they be required for intermediate heights, or times; then proceed as follows:—

Between 7 and 8 feet.

h.	m.	ft.	in.	
8	30			
		7 give	1	10
		8 ,,	2	1
		in.		
4	½	)	3	add.
			1	
		ft.	in.	
		7	4 give	1 11

h.	m.	ft.	in.	
4	0			
		7 give	3	6
		8 ,,	4	0
		in.		
4	½	)	6	add.
			2	
		ft.	in.	
		7	4 give	3 8

Between 8 30 and 4 0

h.	m.		ft.	in.	
8	30	give	1	11	
4	0	,,	3	8	
			1	9	
			12		add.
30 : 8 : :			21		
			8		
		3,0)	16,8		
			5		
			2	4	

Thus the correction corresponding to 8h. 30m. from H.W. and 7ft. 4in. above the mean level of the sea is 2ft. 4in., which differs from 1ft. 10in. by 6 inches.

There is a great deal of trouble in interpolating in Table B as above. The following Rule kindly given to the author by Capt. Wm. B. Duncan enables the student to find the correction very easily by using Table II.

Rule.—Find the half difference between 3 hours, and the time from high water. If there be no hours in this half difference, consider the minutes as degrees. If there be 1 hour in it add 60 to the minutes, and consider the sum as degrees. Enter Table II. with those degrees, and the height above the mean level in the "dist" column, and the corresponding "dep" is the correction given in Table B. To be added if the time from high water be less than 3 hours, but to be subtracted if the time be greater than 3 hours.

Taking the preceding example.

h.	m.			ft.	in.	
8	0			7	4	Height above mean level.
8	38	Time from high water	=	7·3		when expressed in decimals
2)38		Diff.				
19		Half Diff.				

19° in Table II., considered as a course, and 7·3 considered as a distance, give 2·38 as a departure.

ft.
2·38
12
4·56

Thus the correction to the nearest inch is 2ft. 5in., which is nearly the same as is found by the preceding troublesome interpolation; and it is to be subtracted because the time from high water is greater than 3 hours.

Assuming that the rise and fall of the tide may be represented by a circle whose diameter is the mean spring range, Capt. Duncan's method is mathematically correct, but the following slight modification of it by the author is a very close approximation, and it does away with the necessity of reducing the quantities to decimals.

Rule.—Find the degrees in Table II. as before, and consider the height above the mean level, namely: 7 ft. 4 in. as the number 74 in a "dist." column and the corresponding "dep." 24·1.

Consider the decimal point to be shifted one place to the left, it thus becomes 2·41, which consider as 2 ft. 4 in. As the second decimal is below 5, reject it, if it were 5 or upwards then add 1 to the first decimal.

Thus the correction is the same as is found by interpolation.

Note.—The error of the correction as found by this method will never exceed 2 inches, as any person may convince himself by examining Table B. by it.

Example II.—1881, on September 16th, at 4 p.m., off Harwich, took a cast of the lead; required the correction to be subtracted.

		d.	h.	m.			ft.	in.
T.H.W.	Harwich	16	5	41	P.M.	H.T. Harwich	9	5
M.T.S.		16	4	0	P.M.	½ M.S.R.	5	9
T. from H.W.			1	41		Above M.L.	8	8

		ft.	in.
½ M.S.R.		5	9
Corr. Table B.	+	2	10
Answer		8	7 to be subtracted.

BY TABLE II.

	h.	m.	
T. from H.W.	1	41	less than 8 h +
	8	0	
	2)1	19	

39° and 38 dist. give 23·9 dep.

		ft.	in.
½ M.S.R.		5	9
Corr.	+	2	4
Answer		8	1 to be subtracted.

Example III.—1881, January 12th, at 6 A.M., off North Shields, took a cast; required the correction.

		d.	h.	m.			ft.	in.
T.H.W.	Shields	12	1	17	A.M.	H.T.	10	2
M.T.S.		12	6	0	A.M.	½ M.S.R.	6	8
T. from H.W.			4	43		Above M.L.	8	6

		ft.	in.
½ M.S.R.		6	8
Corr. Table B.	—	2	10
Answer		8	10 to be subtracted.

BY TABLE II.

	h.	m.	
T. from H.W.	4	43	more than 8 h. —
	8	0	
	2)1	43	

51° and 36 dist. give 28·0 dep.

		h.	m.	
½ M.S.R.		6	8	
Corr.	—	2	8	
Answer		4	0	to be subtracted

Example IV.—1881, January 18th at 6 A.M., off Weston Super Mare, took a cast, required the correction?

	d.	h.	m.			ft.	in.
T.H.W. Weston	18	8	31	A.M.	H.T.	35	9
M.T.S.	18	6	0	A.M.	½ M.S.R.	18	7
T. from H.W.		2	31			17	2

	ft.	in.
½ M.S.R.	18	7
Corr. Table B	+ 4	5
Answer	23	0; to be subtracted

BY TABLE II.

	h.	m.	
T. from H.W.	2	31	less than 3h +
	3	0	
	2) 29		

14° and 172 dist. give 41·6 dep.

	ft.	in.	
½ M.S.R.	18	7	
	+ 4	2	
Answer	22	9	to be subtracted

Example V.—1881, January, at midnight, between 11th and 12th, off North Shields, took a cast; required the correction?

	d.	d.	m.			ft.	in.
T.H.W. Shields	12	1	17	A.M.	H.T.	10	2
M.T.S	12	0	0	Midnight	½ M.S.R.	6	8
T. from H.W.		1	17		Above M.L.	3	6

	ft.	in.	
½ M.S.R.	6	8	
Corr. Table B	+ 2	10	
Answer	9	6	to be subtracted

BY TABLE II.

	ft.	in.	
T. from H.W.	1	17	less than 3h. +
	3	0	
	2)1	43	
			51° and 36 dist. give 28·0 dep.
	ft.	in.	
½ M.S.R.	6	8	
Corr. +	2	8	
Answer	9	4	to be subtracted.

Example VI.—1881, January 17th, at 4h. 30m. A.M., off North Shields, took a cast; required the correction?

	d.	h.	m.			ft.	in.
T.H.W. Shields	17	4	30	P.M.	H.T.	12	5
M.T.S.	17	4	30	P.M.	½ M.S.R.	6	8
T. from H.W.		0	0		Above M.L.	5	9

	ft.	in.	
½ M.S.R.	6	8	
Corr. Table B +	5	9	
Answer	12	5	to be subtracted

BY TABLE II.

	h.	m.	
T. from H.W.	0	0	less than 3h +
	3	0	
	2)3	0	
	1	30	
		60	
			90° and 59 dist, give 59·0 dep.
	ft.	in.	
½ M.S.R.	6	8	
+	5	9	
	12	5	to be subtracted

When the given place is not a port of reference, but the constants with respect to such a port are given; proceed as follows:—

Example VII.—1881, April 19th, at 4h. 30m. P.M., off Shoreham, took a cast of the lead; required the correction to be applied to it?

Dover is the Standard Port with reference to Shoreham; hence we have.

			d.	h.	m.			ft.	in.
Dover.	T.H.W.	April	19	2	29	P.M.	H.T.	17	6
Shoreham.	Constant		+	0	22		Constant	— 1	2
Shoreham.	T.H.W.	April	19	2	51	P.M.	H.T.	16	4
	M.T.S.		19	4	30	P.M.	½ M.S.R.	9	0
T. from H.W.				1	39		Above M.L.	7	4

	ft.	in.
½ M.S.R.	9	0
Corr. Table B	+ 4	11
Answer	13	11 to be subtracted

Note.—In the Tide Tables, page 154, the Rise in Springs at Shoreham is 18ft.; therefore ½ M.S.R. = (18ft.) ÷ 2 = 9ft.

BY TABLE II.

	h.	m.	
T. from H.W.	1	39	less than 3h +
	3	0	
	2)1	21	
			40° and 74 dist. give 47·6 dep.

	ft.	in.
½ M.S.R.	9	0
	+ 4	8
Answer	13	8 to be subtracted

Example VIII.—1881, May 26th, at 1h. 25m. P.M., off Dunmanus Harbour, took a cast of the lead; required the correction to be applied to the depth shown by the lead.

		d.	h.	m.			ft.	in.
Queenstown	T.H.W. May,	26	8	53	P.M.	H.T.	10	10
Dunmanus	Constants	—	1	4			— 2	4
Dunmanus	T.H.W. May,	26	2	49	P.M.	H.T.	8	6
	M.T.S. May,	26	1	25	P.M.	½ M.S.R.	— 4	9
	T. from H.W.		1	24		Above M.L.	3	9

		ft.	in.
½ M.S.R.		4	9
Corr. Table B.	+	2	10
Answer		7	7 to subtracted.

Note.—In the Tide Tables, page 157, the rise in Springs, at Dunmanus, is 9½ feet; therefore the ½ M S R = (9ft. 6in.) ÷ 2 = 4ft. 9.

BY TABLE II.

	h.	m.	
T. from H.W.	1	24	less than 3h. +
	3	0	
2)	1	36	

48° and 39 as dist. give dep. 29·0.

		ft.	in.
½ M.S.R.		4	9
Corr.	+	2	9
Answer		7	6 to be subtracted.

Example IX.—1881, August, 15th, at 2h. 27m., P.M., off Valentia Harbour, took a cast of the lead; required the correction to be applied to it.

		d.	h.	m.			ft.	in.
Queenstown	T.H.W. Aug.	15	8	51	P.M.	H.T.	10	5
Valentia	Constant	—	1	19		—	0	8
Valentia	T.H.W. Aug.	15	7	32	P.M.	H.T.	9	9
	M.T.S. Aug.	15	2	27	P.M.	½ M.S.R.	5	6
	T. from H.W.		5	5		Above M.L.	4	3

		ft.	in.
½ M.S.R.		5	6
Corr. Table B.	—	3	6
Answer		2	0 to be subtracted.

Note.—In page 158, the rise in Springs at Valentia Harbour, is 11ft, therefore, the ½ M.S.R. = (11ft.) ÷ 2 = 5ft. 6in.

BY TABLE II.

	ft.	in.	
T. from H.W.	5	5	greater than 3h. —
	3	0	
2)	2	5	
	1	2	
		60	

62° and 48 dist. give dep. 38·0.

		ft.	in.
½ M.S.R.		5	6
Corr.	—	3	8
Answer		1	10

to be subtracted.

When the given place is not a Port of Reference, and both constants with respect to such a Port are not given; proceed as follows:—

Example X.—1881, June, 7th, at 5h. 10m. A.M., off Kyle Akin, took a cast of the lead; required the correction.

See pages 156 and 155.

			h.	m.		ft.	in.
Thurso,	Full and change	H.W.	8	28	H.T.	13	3
Kyle Akin,	.....	.....	6	16	.....	15	6
Constants		—	2	12	+	2	3

½ M.S.R. = (15ft. 6in.) ÷ 2 = 7ft. 9in.

		d.	h.	m.			ft.	in.
Thurso,	T.H.W. June,	7	3	52	A.M.	H.T.	9	8
Kyle Akin,	Constants	—	2	12		+	2	3
Kyle Akin,	T.H.W. June,	7	1	40	A.M.	H.T.	11	11
	M.T.S. June,	7	5	10	A.M.	½ M.S.R.	7	9
	T. from H.W.		3	30		Above M.L.	4	2

	ft.	in.
½ M.S.R.	7	9
Corr. Table B —	1	0
Answer	6	9

to be subtracted.

BY TABLE II.

	h.	m.
T. from H.W.	3	30
	3	0
	2)	30

greater than 3h. —

15° and 42 dist. give dep. 10·9.

	ft.	in.
½ M.S.R.	7	9
Corr. —	1	1
Answer	6	8

to be subtracted.

Example XI.—1881, December 8th, at 6h. 40m. P.M., off Killybegs, took a cast of the lead; required the correction.

		h. m.		ft.	in.
Sligo Bay, Full and Change	H.W.	5 18	P.M. H.T.	11	3
Killybegs	.....	5 16	.....	11	3
Constants for Killybegs	—	0 2		0	0

Killybegs ½ M.S.R. = (11ft. 3in.) ÷ 2 = 5ft. 7in.

		d.	h. m.			ft.	in.
Sligo Bay,	T.H.W. Dec,	8	6 54	P.M.	H.T.	10	2
Killybegs,	Constants	—	0 2			0	0
Killybegs,	T.H.W. Dec.,	8	6 52	P.M.	H.T.	10	2
	M.T.S. Dec.,	8	6 40	P.M.	½ M.S.R.	5	7
	T. from H.W.		0 12		Above M.L.	4	7

	ft.	in.
½ M.S.R.	5	7
Corr. Table B. +	4	7
Answer	10	2 to be subtracted.

BY TABLE II.

	h.	m.	
T. from H.W.	0	12	less than 3h. +
	3	0	
	2)2	48	
	1	24	
		60	

84° and 47 dist. give dep. 46·7.

	ft.	in.
½ M.S.R.	5	7
Corr. +	4	7
Answer	10	2 to be subtracted.

Example XII.—1881, February, 10th, at 3h. 40m. P.M., off Rochelle, took a cast of the lead; required the correction.

		h. m.		ft.	in.
Brest	T.H.W. Full and Change	3 47	H.T.	19	0
Rochelle	.....	3 31	.....	17	0
Constants	—	0 16	—	2	0

½ M.S.R. = (17ft.) ÷ 2 = 8ft. 6in.

			d.	h. m.			ft.	in.
Brest	T.H.W.	Feb.,	10	1 45	P.M.	H.T.	14	1
Constants			—	0 16			— 2	0
Rochelle	T.H.W.	Feb.,	10	1 29	P.M.	.....	12	1
M.T.S.		Feb.,	10	8 40	P.M.	½ M.S.R.	8	6
T. from H.W.				2 11		Above M.L.	8	7

	ft.	in.
½ M.S.R.	8	6
Corr. Table B +	2	0
Answer	10	6 to be subtracted.

BY TABLE II.

	h.	m.	
T. from H.W.	2	11	less than 3h. +
	3	0	
	2) 49		

24° and dist. 37 give dep. 15·0.

	ft.	in.
½ M.S.R.	8	6
Corr. +	1	5
Answer	9	11 to be subtracted.

ADDITIONS, ALTERATIONS AND CORRECTIONS SINCE THE "SEAMANSHIP" WAS PRINTED.

DEVIATION OF THE COMPASS.

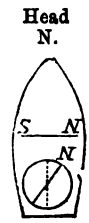
The following questions must be answered fully, and rough diagrams drawn at the side of the answers to shew the position of the correcting magnets and chain boxes.

Question 19. Your steering compass having a large error, how would you proceed to correct that compass by compensating magnets and soft iron, in order to reduce the error within manageable limits?

TO CORRECT THE SEMICIRCULAR DEVIATION.

Draw two chalk lines on the deck, at right angles to each other, one fore and aft, the other athwartships, and with their point of intersection under the centre of the compass needle.

BRING THE SHIP'S HEAD EITHER NORTH OR SOUTH, CORRECT MAGNETIC.



Place a magnet, or, if necessary, two, on the deck, athwartships, either before or abaft the binnacle, with its centre on the fore and aft line.

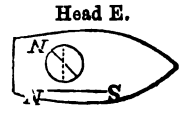
If the North end of the needle deviate towards the Starboard side, place the north end of the magnet towards the Starboard side.

But if it deviate towards the port side, place the North end towards the Port side.

Then move the magnet gradually towards the binnacle, or from it, till the needle points correctly.

NEXT, BRING THE SHIPS HEAD EAST OR WEST, CORRECT MAGNETIC.

Place another magnet on the deck, fore and aft, at either side of the binnacle, with its centre on the athwartship line.



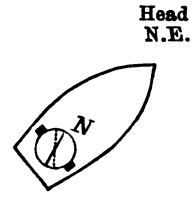
If the North end of the needle deviate towards the Bow, place the north end of the magnet towards the Bow.

But if it deviate towards the Stern, place the North end towards the Stern.

Then move the magnet towards the binnacle, or from it, till the needle points correctly.

TO CORRECT THE QUADRANTAL DEVIATION.

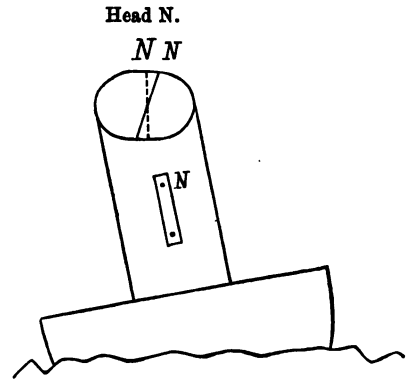
The binnacle being fitted with cast iron correctors, or with small brass boxes, one on each side, port and starboard, of the needle, and at the same height as it.



Then bring the Ship's head on one of the Quadrantal points, N.E., S.E., S.W., or N.W., *correct magnetic.*

Then move the correctors towards the needle or from it or put small chain in the boxes, till the needle points correctly

TO CORRECT THE HEELING ERROR.



When the ship is upright, fix a vertical magnetic case exactly under the centre of the compass needle; bring the ship's head either North or South correct magnetic, and heel her over to either side.

If the North end of the needle deviate to the high side of the ship, place a magnet in the case with its North end upwards.

But if it deviate to the low side which will seldom happen, place the magnet with its north end downwards.

Then move the magnet up or down till the needle points correctly, and fix the magnet in this position.

Note. If the ship change her magnetic latitude considerably, repeat the preceding process.

ADDITIONS TO SUMNER'S METHOD.

The Examiners now require the Candidates to find the Sun's true bearing at the time of taking the first observation in Sumner's Method.

This is done as follows:—

When North of the Sun. Look to the Northward along the first line of bearing; then

When the first observation is taken in the forenoon, allow 90° to the right hand of the first line of bearing, the result is the Sun's true bearing.

When it is taken in the afternoon, allow 90° to the left hand.

When South of the Sun. Look to the Southward.

In the forenoon. Allow 90° to the left hand.

In the afternoon. Allow to the right hand.

Example. In page 162 of the fifth edition of the Seamanship, the first line of bearing is found to be true N. by E. ½ E.

N. by E. ½ E. in degrees is	N. 16	53	E.
Add	90	0	
	N. 106	53	E.
	180	0	
Sun's true bearing	S. 73	7	E.

NOTE. In Sumner's Method; the longitudes given by the Examiners are found with the same assumed latitudes, the second altitude, and the declination and equation of time due to the second Greenwich Date.

AN ACT TO PROVIDE FOR THE SAFE CARRIAGE OF GRAIN CARGOES BY MERCHANT SHIPPING.

Obligation to take precautions to prevent Grain Cargo from Shifting.

3. Where a grain cargo is laden on any British Ship all necessary and reasonable precautions (whether prescribed by this Act or not) shall be taken in order to prevent the grain cargo from shifting.

If such precautions have not been taken in the case of any such ship, the master of the ship, and any agent of the owner who was charged with the loading of the ship or the sending her to sea, shall each be liable to a penalty not exceeding three hundred pounds, and the owner of the ship shall also be liable to the same penalty, unless he shows that he took all reasonable means to enforce the observance of this section, and was not privy to the breach thereof.

Precautions against shifting of Grain Cargo laden in ports in Mediterranean or Black Sea, or on coast of North America.

4. Where a British ship laden with a grain cargo at any port in the Mediterranean or Black Sea is bound to ports outside the Straits of Gibraltar, or where a British Ship is laden with a grain cargo on the coast of North America, the following precautions to prevent the grain cargo from shifting shall be adopted, that is to say:

(*a.*) There shall not be carried between the decks, or, if the ship has more than two decks, between the main and upper decks, any grain in bulk, except such as may be necessary for feeding the cargo in the hold, and is carried in properly constructed feeders.

(*b.*) Where grain (except such as may be carried in properly constructed feeders) is carried in bulk in any hold or compartment and proper provision for filling up the same by feeders is not made, not less than one-fourth of the grain carried in the hold or compartment (as the case may be) shall be in bags supported on suitable platforms laid upon the grain in bulk: provided that this regulation with respect to bags shall not apply—

(i.) To oats, or cotton seed; nor

(ii.) To a ship which is a sailing ship of less than four hundred tons registered tonnage, and is not engaged in the Atlantic trade; nor

(iii.) To a ship laden at a port in the Mediterranean or Black Sea, if the ship is divided into compartments which are formed by substantial transverse partitions, and are fitted with longitudinal bulkheads, or such shifting boards as hereafter in this section mentioned, and if the ship does not carry more than one-fourth of the grain cargo, and not more than one thousand five hundred quarters, in any one compartment, bin, or division, and provided that each division of the lower hold is fitted with properly constructed feeders from the between decks; nor

(iv.) To a ship in which the grain cargo does not exceed one-half of the whole cargo of the ship, and the rest of the cargo consists of cotton, wool, flax, barrels, or sacks of flour, or other suitable cargo so stowed as to prevent the grain in any compartment, bin, or division from shifting.

(*c.*) Where grain is carried in the hold or between the decks, whether in bags or bulk, the hold or the space between the decks shall be divided by a longitudinal bulkhead, or by sufficient shifting boards which extend from deck to deck, or from the deck to the keelson, and are properly secured, and if the grain is in bulk are fitted grain-tight with proper fillings between the beams.

(*d.*) In loading, the grain shall be properly stowed, trimmed and secured.

In the event of the contravention of this section in the case of any ship, reasonable precautions to prevent the grain cargo of that ship from shifting shall be deemed not to have been taken, and the owner and master of the ship and any agent charged with loading her or sending her to sea shall be liable accordingly to a penalty under this Act.

Provided that nothing in this section shall exempt a person from any liability, civil or criminal, to which he would otherwise be subject for failing to adopt any reasonable precautions which, although not mentioned in this section, are reasonably required to prevent grain cargo from shifting.

Exemptions from precautions specified in this Act for ships laden in Mediterranean or Black Sea, or on coast of North America.

5. The precautions required by this Act to be adopted by ships laden with a grain cargo at a port in the Mediterranean or Black Sea, or on the coast of North America, shall not apply to ships loaded in accordance with regulations for the time being approved by the Board of Trade; nor to any ship constructed and loaded in accordance with any plan approved by the Board of Trade.

Notice by Master of kind and quantity of grain cargo.

6. Before a British ship laden with grain cargo at any port in the Mediterranean or Black Sea, bound to ports outside the Straits of Gibraltar, or laden with grain cargo on the coast of North America, leaves her final port of loading, or within forty-eight hours after leaving such port, the master shall deliver, or cause to be delivered, to the British Consular Officer, or, if it is in Her Majesty's dominions, to the principal officer of Customs at that port, a notice stating—

34 & 35 *Vict. c.* 110. 36 & 37 *Vict. c.* 85.

(1.) The draught of water and clear side, as defined by section five of the Merchant Shipping Act, 1871, and section four of the Merchant Shipping Act, 1873, of the said ship after the loading of her cargo has been completed at the said last port of loading;

(2.) And also stating the following particulars in respect to the grain cargo, namely:—

(*a.*) The kind of grain and quantity thereof, which quantity may be stated in cubic feet, or in quarters, or bushels, or in tons weight; and

(*b.*) The mode in which the grain cargo is stowed; and

(*c.*) The precautions taken against shifting.

30 & 40 *Vict. c.* 36 *ss.* 50, 51.

The master shall also deliver a similar notice to the principal collector or other proper officer of Customs in the United Kingdom, together with the report required, to be made by the Customs Consolidation Act, 1876, on the arrival of the ship in the United Kingdom.

Every such notice shall be sent to the Board of Trade as soon as practicable by the officer receiving the same.

If the master fails to deliver any notice required by this section he shall be liable to a penalty not exceeding one hundred pounds: provided always, that the Board of Trade may, by notice published in the London Gazette, or in such other way as it may deem expedient, exempt ships laden at any particular port, or any class of such ships from the provisions of this section.

Penalty for false statement in notice,

7. Any master of a ship, who in any notice required by this Act wilfully makes any false statement or wilfully omits any material particular, shall be liable to a penalty not exceeding one hundred pounds.

Power of Board of Trade for enforcing of Act.

8. For the purpose of securing the observance of this Act, any officer having authority on that behalf from the Board of Trade, either general or special, shall have the same power as an inspector appointed under the Merchant Shipping Act, 1854, and shall also have power to inspect any grain cargo, and the mode in which the same is stowed.

Prosecution of offences and recovery of penalties.

9. Every offence punishable under this act, may be prosecuted summarily, and every penalty under this Act may be recovered and enforced summarily in like manner as offences and penalties under the Merchant Shipping Act, 1854, and the Acts amending the same.

Definitions.

10. For the purposes of this Act—

The expression "grain" means any corn, rice, paddy, pulse, seeds, nuts, or nut kernels.

The expression "ship laden with grain cargo" means a ship carrying a cargo of which the portion consisting of grain is more than one-third of the registered tonnage of the ship, and such third shall be computed, where the grain is reckoned in measures of capacity, at the rate of one hundred cubic feet for each ton of registered tonnage, and where the grain is reckoned in measures of weight, at the rate of two tons weight for each ton of registered tonnage.

Repeal of 39 & 40 *Vict. c.* 80 *s.* 22

11. Section twenty-two of the Merchant Shipping Act, 1876, is hereby repealed as from the commencement of this Act:

Provided that any offence against that section committed before the commencement of this Act may be prosecuted, and the penalty recovered and enforced in like manner as if the said section had continued to remain in force.

QUESTIONS ON GRAIN CARGOES.

Q. If a master do not take precautions to prevent grain cargo from shifting, what penalty is he liable to ?

A. Not exceeding £300.

Q. When a ship from the Mediterranean or Black Sea to ports outside of the Straits of Gibraltar, or from North America, is laden with grain; what precautions should be taken against the grain shifting ?

A. There shall not be carried between decks, or between the main and upper Deck, any grain in bulk, except in feeders for feeding the cargo in the hold.

Q. What proportion of cargo in any compartment shall be in bags ?

A. Not less than one-fourth.

Q. How shall the bags be supported ?

A. On platforms laid on the grain in bulk.

Q. To what cargoes and ships do the regulations about bags not apply ?

A. To oats or cotton seed.

To sailing ships, less than 400 tons register, not in the Atlantic trade.

To ships from the Mediterranean or Black Sea, fitted with compartments, with fore and aft bulkheads, and feeders to each compartment; not to contain more than one-fourth of the cargo, and not more than 1500 quarters in any compartment.

To a ship in which the grain does not exceed one-half of the whole cargo, and the rest consists of cotton, wool, flax, barrels or sacks of flour, so stowed as to prevent the cargo from shifting.

Q. When grain is carried in bags, or bulk, how should it be secured ?

A. By a fore and aft bulkhead, or shifting boards grain tight, from deck to deck, or from deck to keelson, with fittings between the beams.

Q. What further precautions will you take ?

A. Stow, trim, and secure the cargo properly.

Q. Shall the precautions apply to ships loaded in accordance with any plan approved by the Board of Trade ?

A. No.

Q. What notice shall the master give to the consul at the port of loading, and the collector of customs at the port of discharge ?

A. The draught of water and clear side. The kind and quantity of grain. How the grain is stowed, and what precautions are taken against it shifting.

Q. If the master fail to give such notice, or make any false statement, or omit any material particular, what penalty is he liable to ?

A. £100.

Exn. 9 a.

Port of

Rotation No.

ADJUSTMENTS OF THE SEXTANT.

The applicant will answer in writing, on a sheet of paper which will be given him by the examiner, all the following questions; numbering his answers with the numbers corresponding to the questions.

Question.

1 What is the first adjustment of the sextant?
2 How do you make that adjustment?
3 What is the second adjustment?
4 Describe how you make that adjustment.
5 What is the third adjustment?
6 How would you make the third adjustment?
7 In the absence of a screw how would you proceed?
8 How would you find the index error by the horizon?
9 How is it to be applied?
10 Place the index at error of minutes to be added, clamp it, and leave it.

(NOTE.—The examiner will see that it is correct.)

11 The examiner will then place the zero of the vernier on the arc, not near any of the marked divisions, and the candidate will read it.

NOTE.—In all cases the applicants will name or otherwise point out the screws used in the various adjustments.

The above *completes the examination of second* and only Mates.

In addition to the above, only Mates, first Mates, and Masters will be required to state in writing:—

12 How do you find the index error by the Sun?

13 The readings being { 35·0 off / 32·0 on } What is the index error, and how do you apply it?

14. What proof have you that those measurements or angles have been taken with tolerable accuracy?

Elements from the Tide Tables for the Examples, 1880.

Example	Standard Port.	Date of Tide.		Given Port.	Constant.
		d. h. m.			h. m.
I.	Brest	June	2 11 32 A.M.	Gibraltar	— 2 0
		,,	8 0 5 P.M.		
II.	Brest	June.....	1 10 59 P.M.	Bordeaux	+ 3 3
		,,	2 11 32 A.M.		
III.	Brest	June.....	2 11 32 A.M.	Bayonne	— 0 2
		,, ...	3 0 5 A.M.		
IV.	Holyhead...	April.....	2 2 50 A.M.	Fishguard	— 3 15
		,, ...	2 3 28 P.M.		
V.	Queenstown	September	14 0 15 A.M.	Skull	— 0 59
		,,	14 0 59 P.M.		
		,,	15 0 41 A.M.		
VI.	Londonderry	December	8 0 59 P.M.	Coleraine	— 1 37
		,,	9 1 37 A.M.		
		,,	8 0 22 A.M.		

TIDE TABLES FOR JULY, 1880.

Week Day.	Month Day.	Moon's Transit.	BREST (*Entr. of Dockyard Basin.*)				DEVONPORT (*H.M. Dockyard.*)				PORTSMOUTH. (*H.M. Dockyard.*)			
			Morning.		Afternoon.		Morning.		Afternoon.		Morning.		Afternoon.	
			Time	Height	Time	Height	Time	Height	Time	Height	Time	Height	Time	Height
		H. M.	H. M.	F. I.	H. M.	F. I.	H. M.	F. I.	H. M.	F. I.	H. M.	F. I.	H. M.	F. I.
Th.	1	7 11	10 38	13 10	11 12	13 8	—	—	0 4	12 1	5 57	10 9	6 28	10 8
F.	2	7 57	11 47	13 8	——	—	0 39	12 1	1 14	12 1	7 1	10 7	7 35	10 8
S.	3	8 45	0 22	13 10	0 54	14 1	1 48	12 2	2 22	12 4	8 10	10 9	8 44	10 11
S.	4	9 34	1 24	14 5	1 51	14 10	2 54	12 5	3 25	13 0	9 15	11 1	9 44	11 3
M.	5	10 23	2 15	15 3	2 36	15 8	3 55	12 11	4 20	13 8	10 9	11 6	10 31	11 9
Tu.	6	11 13	2 55	16 1	3 14	16 6	4 44	13 4	5 5	14 2	10 51	11 11	11 10	12 0
W.	7	0a 2	3 33	16 9	3 52	17 0	5 24	13 8	5 43	14 7	11 29	12 2	11 48	12 4
Th.	8	0 49	4 10	17 2	4 28	17 3	6 2	13 11	6 20	15 0	—	—	0 7	12 5
F.	9	1 35	4 45	17 5	5 1	17 7	6 38	14 2	6 55	15 2	0 25	12 6	0 43	12 7
S.	10	2 19	5 17	17 8	5 34	17 9	7 10	14 2	7 25	15 0	1 1	12 7	1 18	12 8

TIDAL CONSTANTS.

Ports of Great Britain.	Constants.		Standard Port for Reference.
	Time.	Height.	
	h. m.	ft. in.	
Selsea Bill	+ 0 4		Portsmouth
Bembridge Point	— 0 41		,,
Christchurch	— 2 41		,,
Poole	— 2 31		,,
Plymouth Breakwater ...	— 0 6		Devonport
Fowey	— 0 29		,,
Falmouth	— 0 46		,,
Penzance	— 1 18		,,
WESTERN COAST OF EUROPE.			
Bayonne	— 0 2		Brest.
Arachon	+ 0 50		,,
Bordeaux	+ 3 3		,,
Port Navalo...	— 0 5		,,

MARCH, 1877.

AT APPARENT NOON.

Day of the Week.	Day of the Month.	THE SUN'S *Apparent* Right Ascension.	Var. in 1 hour.	THE SUN'S *Apparent* Declination.	Var. in 1 hour.	Sidereal Time of the Semi-diameter passing the Meridian.*	Equation of Time, *to be added to Apparent Time.*	Var. in 1 hour.
		h. m. s.	s.	° ′ ″	″	m. s.	m. s.	s.
Mon.	19	23 56 24·50	9·108	S. 0 23 21·9	59·27	1 4·52	7 50·69	0·746
Tues.	20	0 0 3·02	9·102	N. 0 0 20·4	59·24	1 4·50	7 32·70	0·752
Wed.	21	0 3 41·40	9·097	0 24 1·7	59·20	1 4·49	7 14·58	0·757
		APRIL, 1877.					Added to / Subt. from App. Time.	
Frid.	13	1 27 34·52	9·215	9 11 29·4	54·23	1 4·90	0 28·07	0·640
Sat.	14	1 31 15·84	9·229	9 33 6·4	53·84	1 4·95	0 12·88	0·626
Sun.	15	1 34 57·50	9·243	9 54 33·9	53·44	1 5·00	0 1·97	0·611
		JUNE, 1877.					Subt. from / Added to App. Time.	
Wed.	13	5 27 23·08	10·381	23 14 44·6	8·09	1 8·89	0 13·22	0·524
Thur.	14	5 31 32·31	10·387	23 17 46·4	7·06	1 8·91	0 0·58	0·529
Frid.	15	5 35 41·66	10·391	23 20 28·5	6·08	1 8·93	0 12·17	0·533
		AUGUST, 1877.					Added to / Subt. from App. Time.	
Tues.	28	10 28 14·50	9·120	9 35 58·9	53·14	1 4·58	0 59·64	0·735
Wed.	29	10 31 53·20	9·106	9 14 38·9	53·52	1 4·53	0 41·84	0·749
Thur.	30	10 35 31·57	9·092	8 53 10·0	53·89	1 4·48	0 23·71	0·762
Frid.	31	10 39 9·63	9·080	8 31 32·3	54·24	1 4·43	0 5·27	0·774
Sat.	32	10 42 47·41	9·068	N. 8 9 46·3	54·58	1 4·39	0 13·45	0·786
		SEPTEMBER, 1877.					Subt. from App. Time.	
Sat.	22	11 58 21·90	8·981	N. 0 10 38·7	58·44	1 4·09	7 25·41	0·873
Sun.	23	12 1 57·50	8·986	S. 0 12 44·5	58·48	1 4·11	7 46·31	0·868
Mon.	24	12 5 33·23	8·992	0 36 8·4	58·50	1 4·13	8 7·08	0·862
		DECEMBER, 1877.					Subt. from / Added to App. Time.	
Sat.	22	18 3 32·61	11·107	23 27 16·7	0·93	1 11·29	1 2·36	1·247
Sun.	23	18 7 59·18	11·107	23 26 40·2	2·11	1 11·29	0 32·43	1·247
Mon.	24	18 12 25·73	11·105	23 25 35·3	3·29	1 11·28	0 2·52	1·245
Tues.	25	18 16 52·23	11·102	23 24 2·2	4·47	1 11·27	0 27·34	1·242
Wed.	26	18 21 18·65	11·099	23 22 0·8	5·65	1 11·26	0 57·11	1·238
Thur.	27	18 25 44·96	11·093	23 19 31·1	6·82	1 11·24	1 26·78	1·233

MARCH, 1877.

AT MEAN NOON.

Day of the Week.	Day of the Month.	THE SUN'S Apparent Right Ascension.	THE SUN'S Apparent Declination.	THE SUN'S Semi-diameter.*	Equation of Time, *to be subtracted from Mean Time.*	Sidereal Time.
		h. m. s.	° ′ ″	′ ″	m. s.	h. m. s.
Mon.	19	23 56 28·31	S. 0 23 29·7	16 5·4	7 50·79	23 48 32·52
Tues.	20	0 0 1·87	N. 0 0 13·0	16 5·1	7 32·80	23 52 29·07
Wed.	21	0 3 40·30	0 23 54·6	16 4·8	7 14·67	23 56 25·63
			APRIL, 1877.		Subt. from / Added to Mean Time.	
Frid.	13	1 27 34·45	9 11 29·0	15 58·5	0 28·08	1 27 6·37
Sat.	14	1 31 15·80	9 33 6·2	15 58·2	0 12·88	1 31 2·92
Sun.	15	1 34 57·50	9 54 34·0	15 57·9	0 1·97	1 34 59·48
			JUNE, 1877.		Added to / Subt. from Mean Time.	
Wed.	13	5 27 23·12	23 14 44·6	15 46·7	0 13·22	5 27 36·34
Thur.	14	5 31 32·31	23 17 46·4	15 46·7	0 0·58	5 31 32·89
Frid.	15	5 35 41·62	23 20 23·5	15 46·6	0 12·17	5 35 29·45
			AUGUST, 1877.		Subt. from / Added to Mean Time.	
Tues.	28	10 28 14·35	9 35 59·8	15 52·7	0 59·66	10 27 14·69
Wed.	29	10 31 53·09	9 14 39·5	15 52·9	0 41·85	10 31 11·24
Thur.	30	10 35 31·51	8 53 10·3	15 53·2	0 23·71	10 35 7·80
Frid.	31	10 39 9·62	8 31 32·4	15 53·4	0 5·27	10 39 4·35
Sat.	32	10 42 47·45	N. 8 9 46·1	15 53·6	0 13·46	10 43 0·90
			SEPTEMBER, 1877.		Added to Mean Time.	
Sat.	22	11 58 23·01	N. 0 10 31·4	15 59·0	7 25·52	12 5 48·53
Sun.	23	12 1 58·66	S. 0 12 52·1	15 59·2	7 46·42	12 9 45·09
Mon.	24	12 5 34·45	0 36 16·3	15 59·5	8 7·19	12 13 41·64
			DECEMBER, 1877.		Added to / Subt. from Mean Time.	
Sat.	22	18 3 32·81	23 27 16·7	16 18·0	1 2·34	18 4 35·15
Sun.	23	18 7 59·28	23 26 40·2	16 18·1	0 32·42	18 8 31·71
Mon.	24	18 12 25·74	23 25 35·3	16 18·1	0 2·52	18 12 28·26
Tues.	25	18 16 52·15	23 24 2·2	16 18·1	0 27·33	18 16 24·82
Wed.	26	18 21 18·48	23 22 0·8	16 18·2	0 57·09	18 20 21·38
Thur.	27	18 25 44·69	23 19 31·2	16 18·2	1 26·75	18 24 17·94

I. JANUARY, 1884.

AT APPARENT NOON.

Day of the Week.	Day of the Month.	THE SUN'S *Apparent* Right Ascension.	Var. in 1 hour.	THE SUN'S *Apparent* Declination.	Var. in 1 hour.	Sidereal Time of the Semi-diameter passing the Meridian.*	Equation of Time, *to be added to Apparent Time.*	Var. in 1 hour.
		h. m. s.	s.	° ′ ″	″	m. s.	m. s.	s.
Tues.	1	18 45 52·31	11·049	S. 23 1 58·8	12·10	1 11·08	3 38·26	1·189
Wed.	2	18 50 17·32	11·034	22 56 54·1	13·25	1 11·04	4 6·64	1·175
Thur.	3	18 54 41·96	11·018	22 51 22·4	14·39	1 10·99	4 34·65	1·159
				FEBRUARY, 1884.			Added to App. Time.	
Thur.	7	21 22 29·68	9·991	15 23 16·8	46·71	1 7·60	14 21·30	0·134
Frid.	8	21 26 29·05	9·957	15 4 28·0	47·35	1 7·49	14 24·11	0·100
Sat.	9	21 30 27·61	9·923	14 45 24·0	47·97	1 7·38	14 26·11	0·067
				MARCH, 1884.			Added to App. Time.	
Wed.	19	23 57 28·73	9·106	S. 0 16 23·6	59·25	1 4·52	7 42·79	0·749
Thur.	20	0 1 7·20	9·101	N. 0 7 18·1	59·22	1 4·50	7 24·76	0·753
Frid.	21	0 4 45·58	9·097	0 30·59·0	59·18	1 4·49	7 6·64	0·757
				APRIL, 1884.			Added to / Sub. from App. Time.	
Sun.	13	1 28 40·90	9·214	9 17 50·6	54·08	1 4·92	0 22·86	0·640
Mon.	14	1 32 22·21	9·229	9 39 23·9	53·69	1 4·97	0 7·16	0·626
Tues.	15	1 36 3·88	9·244	10 0 47·6	53·28	1 5·02	0 7·68	0·610
				MAY, 1884.			Sub. from App. Time.	
Mon.	19	3 46 29·71	9·982	19 54 50·4	31·58	1 7·56	3 44·10	0·125
Tues.	20	3 50 29·56	10·005	20 7 18·2	30·73	1 7·63	3 40·81	0·149
Wed.	21	3 54 29·97	10·029	20 19 25·5	29·87	1 7·71	3 36·97	0·171
				JUNE, 1884.			Sub. from / Added to App. Time.	
Frid.	13	5 28 38 98	10·377	23 15 22·5	7·77	1 8·90	0 9·32	0·520
Sat.	14	5 32 48 12	10·384	23 18 16·7	6·75	1 8·92	0 3·23	0·526
Sun.	15	5 36 57 41	10·390	23 20 46·3	5·72	1 8·94	0 15·92	0·531

JANUARY, 1884. II.

AT MEAN NOON.

Day of the Month.	Day of the Week.	THE SUN'S *Apparent* Right Ascension.	THE SUN'S *Apparent* Declination.	THE SUN'S Semi-diameter.*	Equation of Time, *to be subtracted from Mean Time.*	Sidereal Time.
		h. m. s.	° ′ ″	′ ″	m. s.	h. m. s.
Tues.	1	18 45 51·64	S. 23 1 59·1	16 18·2	3 38·19	18 42 13·45
Wed.	2	18 50 16·56	22 56 55·0	16 18·2	4 6·56	18 46 10·01
Thur.	3	18 54 41·12	22 51 23·5	16 18·2	4 34·56	18 50 6·56
		FEBRUARY, 1884.			Sub. from Mean Time.	
Thur.	7	21 22 27·29	15 23 28·0	16 14·9	14 21·27	21 8 6·01
Frid.	8	21 26 26·66	15 4 39·4	16 14·8	14 24·09	21 12 2·57
Sat.	9	21 30 25·22	15 45 35·6	16 14·6	14 26·10	21 15 59·12
		MARCH, 1884.			Sub. from Mean Time.	
Wed.	19	23 57 27·56	S. 0 16 31·2	16 5·3	7 42·89	23 49 44·67
Thur.	20	0 1 6·08	N. 0 7 18·8	16 5·1	7 24.86	23 53 41·22
Frid.	21	0 4 44·50	0 30 52·0	16 4·8	7 6·73	23 57 37·77
		APRIL, 1884.			Sub. from / Added to Mean Time.	
Sun.	12	1 28 40·84	9 17 50·3	15 58·5	0 22·36	1 28 18·47
Mon.	14	1 32 22·19	9 39 23·8	15 58·2	0 7·16	1 32 15·03
Tues.	15	1 36 3·90	10 0 37·7	15 57·9	0 7·68	1 36 11·58
		MAY, 1884.			Added to Mean Time.	
Mon.	19	3 46 30·33	19 54 52·4	15 50·1	3 44·09	3 50 14·42
Tues.	20	3 50 30·17	20 7 20·1	15 49·9	3 40·80	3 54 10·98
Wed.	21	3 54 30·57	20 19 27·3	15 49·8	3 36·96	3 58 7·53
		JUNE, 1884.			Added to / Sub. from Mean Time.	
Frid.	13	5 28 39·01	23 15 22·5	15 46·8	0 9·32	5 28 48·33
Sat.	14	5 32 48·11	23 18 16·7	15 46·7	0 3·23	5 32 44·89
Sun.	15	5 36 57·36	23 20 46·3	15 46·6	0 15·92	5 36 41·44

I. JULY, 1884.

AT APPARENT NOON.

Day of the Week.	Day of the Month.	THE SUN'S *Apparent* Right Ascension.	Var. in 1 hour.	THE SUN'S *Apparent* Declination.	Var. in 1 hour.	Sidereal Time of the Semi-diameter passing the Meridian*	Equation of Time, *to be added to Apparent Time.*	Var. in 1 hour.
		h m s	s.	° ′ ″	″	m s	m s	s.
Tues.	22	8 8 46·45	9·947	20 9 31·7	30·89	1 7·43	6 11·39	0·091
Wed.	23	8 12 44·90	9·928	19 57 12·3	31·22	1 7·34	6 13·28	0·066
Thur.	24	8 16 42·75	9·898	19 44 33·0	32·05	1 7·26	6 14·58	0·041
		AUGUST, 1884.					Added to / Sub. from App. Time.	
Thur.	28	10 29 22·75	9·118	9 29 11·5	53·26	1 4·56	0 56·05	0·737
Frid.	29	10 33 1·89	9·103	9 7 48·8	53·63	1 4·51	0 38·19	0·751
Sat.	30	10 36 39·68	9·088	8 46 17·4	53·98	1 4·46	0 19·98	0·766
Sun.	31	10 40 17·63	9·075	8 24 37·7	54·32	1 4·42	0 1·43	0·780
		SEPTEMBER, 1864.					Sub. from App. Time.	
Mon.	22	11 59 28·78	8·989	N. 0 3 23·4	58·48	1 4·09	7 30·33	0·865
Tues.	23	12 3 4·57	8·994	S. 0 20 0·6	58·51	1 4·11	7 51·04	0·860
Wed.	24	12 6 40·49	9·000	0 43 25·0	58·52	1 4·13	8 11·62	0·854
		OCTOBER, 1884.					Sub. from App. Time.	
Sat.	25	14 1 10·84	9·597	12 20 37·6	51·45	1 6·24	15 53·12	0·259
Sun.	26	14 5 1·52	9·627	12 41 6·7	50·97	1 6·34	15 58·98	0·229
Mon.	27	14 8 52·92	9·657	13 1 24·0	50·46	1 6·45	16 4·11	0·199
		NOVEMBER, 1884.					Sub. from App. Time.	
Frid.	28	16 19 28·15	10·732	21 26 30·8	25·70	1 10·07	11 39·37	0·874
Sat.	29	16 23 46·07	10·760	21 36 35·4	24·68	1 10·16	11 18·07	0·901
Sun.	30	16 28 4·64	10·787	21 46 15·2	23·64	1 10·25	10 56·11	0·028
		DECEMBER, 1884.					Sub. from / Added to App. Time.	
Mon.	22	18 4 53·61	11·111	23 26 48·2	1·29	1 11·28	0 53·04	1·251
Tues.	23	18 9 20·27	11·110	23 26 3·0	2·47	1 11·28	0 23·02	1·249
Wed.	24	18 13 46·86	11·106	23 24 49·5	3·65	1 11·27	0 6·93	1·246

JULY, 1884.

AT MEAN NOON.

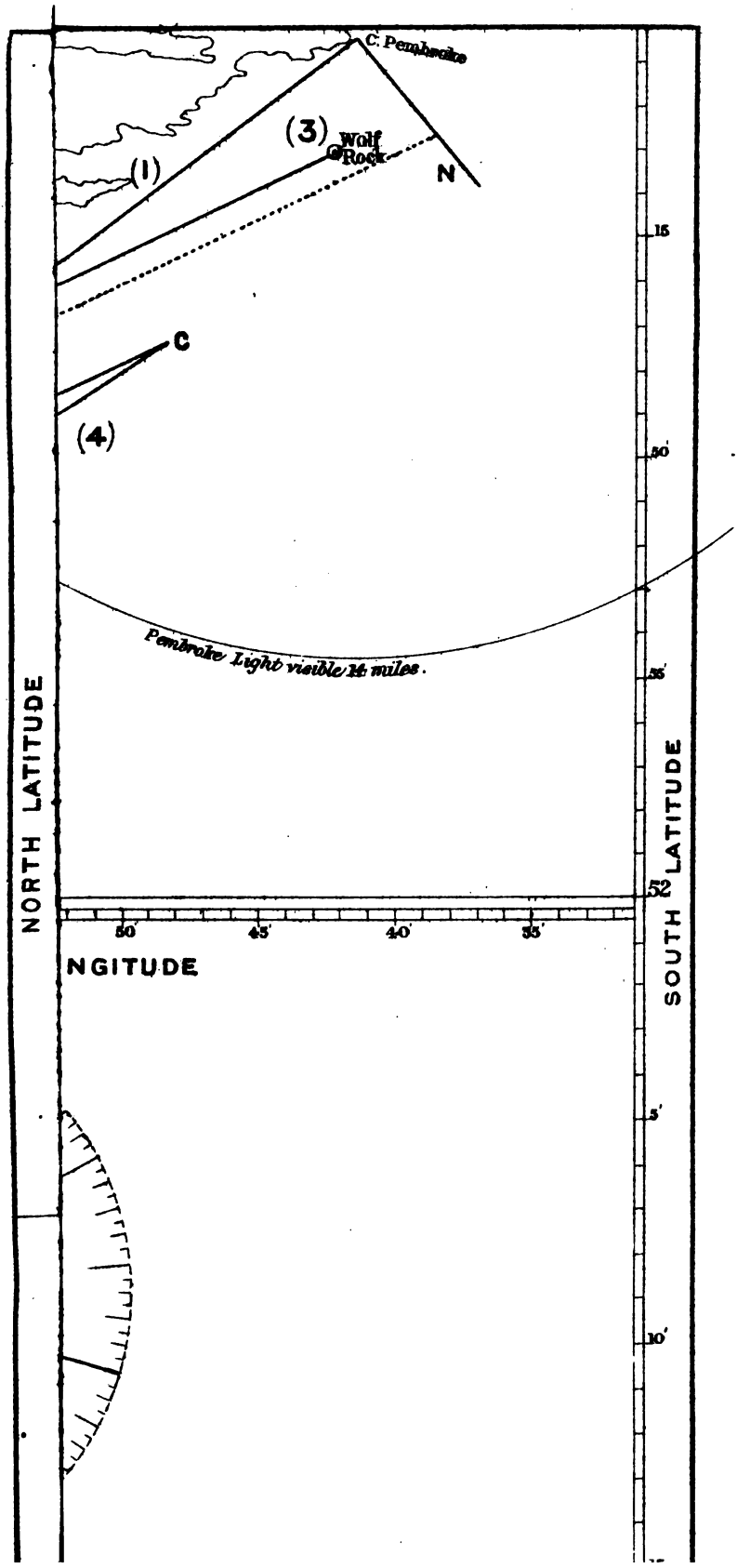
Day of the Week.	Day of the Month.	THE SUN'S *Apparent* Right Ascension.	THE SUN'S *Apparent* Declination.	THE SUN'S Semi-diameter.*	Equation of Time, *to be subtracted from Mean Time.*	Sidereal Time.
		h. m. s.	° ′ ″	′ ″	m. s.	h. m. s.
Tues.	22	8 8 45·33	20 9 34·8	15 46·8	6 11·38	8 2 34·04
Wed.	23	8 12 43·87	19 57 15·5	15 46·9	6 13·27	8 6 30·60
Thur.	24	8 16 41·72	19 44 36·3	15 47·0	6 14·57	8 10 27·15
		AUGUST, 1884.			Sub. from / Added to Mean Time.	
Thur.	28	10 29 22·61	9 29 12·4	15 52·8	0 56·06	10 28 26·55
Frid.	29	10 33 1·30	9 7 49·4	15 53·0	0 38·20	10 32 23·10
Sat.	30	10 36 39·63	8 46 17·7	15 53·2	0 19·98	10 36 19·65
Sun.	31	10 40 17·63	8 24 37·7	15 53·5	0 1·43	10 40 16·20
		SEPTEMBEB, 1884.			Added to Mean Time.	
Mon.	22	11 59 29·91	N. 0 8 16·1	15 59·0	7 30·44	12 7 0·35
Tues.	23	12 3 5·75	S. 0 20 9·2	15 59·2	7 51·15	12 10 56·90
Wed.	24	12 6 41·72	0 43 33·0	15 59·5	8 11·73	12 14 53·45
		OCTOBER, 1884.			Added to Mean Time.	
Sat.	25	14 1 13·38	12 20 51·2	16 8·0	15 53·19	14 17 6·57
Sun.	26	14 5 4·09	12 41 20·3	16 8·3	15 59·04	14 21 3·12
Mon.	27	14 8 55·51	13 1 37·5	16 8·5	16 4·17	14 24 59·68
		NOVEMBER, 1884.			Added to Mean Time.	
Frid.	28	16 19 30·24	21 26 35·8	16 15·4	11 39·20	16 31 9·43
Sat.	29	16 23 48·09	21 36 40·0	16 15·6	11 17·90	16 35 5·99
Sun.	30	16 28 6·60	21 46 19·5	16 15·8	10 55·94	16 39 2·55
		DECEMBER, 1884.			Added to / Sub. from Mean Time.	
Mon.	22	18 4 53·78	23 26 48·2	16 18·0	0 53·02	18 5 46·80
Tues.	23	18 9 20·34	23 26 3·0	16 18·0	0 23·01	18 9 43·36
Wed.	24	18 13 46·84	23 24 49·5	16 18·1	0 6·93	18 13 39·91

TABLE.

DECLINATION OF THE FIXED STARS.

DATE, 1877.

Month and Day.	Star's Name.	Declination.
		° ′ ″
August 30th. ...	α Coronœ (Alphacca)	27 7 45 N.
February 11th. ...	α Pegasi (Markab)	14 32 36 N.
January 20th ...	α Piscis Australis (Fomalhaut)	30 16 36 S.
May 7th. ...	α Orionis (Betelguese)	7 23 1 N.
December 8th. ...	α Lyæ (Vega)	38 40 15 N.
June 12th. ...	α Scorpii (Antarcs)	26 9 41 S.
January 11th. ...	γ Pegasi (Algenib).....	14 32 25 N.
February 20th. ...	α Eridani (Achernar)	57 49 49 S.
March 9th. ...	α Tauri (Aldebaran).....	16 16 21 N.
April 21st. ...	α Aurigæ (Capella)	45 52 40 N.
May 18th. ...	β Orionis (Rigel)	8 20 23 S.
June 10th. ...	α Argus (Canopus)	52 38 13 S.
July 28th. ...	α Canis Majoris (Sirius)	16 33 35 S.
August 19th ...	α^2 Geminorum (Castor)	32 8 17 N.
September 6th. ...	α Canis Minoris (Procyon)	5 31 8 N.
October 16th. ...	β Geminorum (Pollux)	28 18 1 N.
November 25th. ...	α Leonis (Regulus)	12 31 39 N.
December 17th. ...	α Virginis (Spica)	10 33 23 S.


C. Pembroke
(3)
Wolf Rock
(1)
N
C
(4)
15
30
45
52
55
5
10
Pembroke Light visible 14 miles.
NORTH LATITUDE
SOUTH LATITUDE
50
45
40
35
NGITUDE